Environmental Compliance Inspector Grade II

Certification Examination

Study Guide

CALIFORNIA WATER ENVIRONMENT ASSOCIATION

California Water Environment Association

Grade II Environmental Compliance Inspector Study Guide

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Important Notice: CWEA is pleased that you have purchased this book. We want to remind you that this book is one of many resources available to assist you, and we encourage you to identify and utilize the other resources in preparing for your next test.

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Section 1

Introduction

The California Water Environment Association (CWEA) Technical Certification Program (TCP) is voluntary; its purpose is to educate, prepare, and test an individual's knowledge within six vocations.

- Plant Maintenance (with two parallel specialties of Electrical/ Instrumentation, and Mechanical Technologist)
- Laboratory Analyst
- Collection System Maintenance
- Environmental Compliance Inspector
- Industrial Waste Treatment Plant Operator
- Biosolids Land Application Management

CWEA also assists in educating and training wastewater treatment plant operators for the State of California Operator Certification Tests. Upon qualifying and successfully completing a test, an individual is certified in that specialty at one of the grade levels. Levels within a specialty designate technical knowledge for the apprentice, journey, and management levels. Tests are designed to demonstrate minimum competence for a particular grade.

The purpose of this study guide is to provide a description of the knowledge, skills, and abilities (KSA) needed to pass the test. Also included are questions designed to assess a candidate's strengths and weaknesses relative to their present KSA. Finally, the study guide provides references used to refresh subject knowledge, or to learn more about particular subject areas not completely understood.

Typically there are two to five primary references for each specialty area which need to be read and understood. Test questions are generally based on information contained in these references. Secondary references give more information and often provide a different approach to a subject making it easier to understand.

This study guide is not a compendium of all that may be on the test, so successfully answering questions contained in this guide does not guarantee passing. To successfully pass the Grade I Collection System Maintenance test, the reference materials presented in this study guide should be thoroughly understood.

This study guide can best be used to help identify strengths and weaknesses and to identify material that may need further study. Comments and suggestions to improve the study guide are always welcome and appreciated. Good luck on the test!

Section 2

Certification Program Information and Policies

CWEA's mission is to enhance the education and effectiveness of California wastewater professionals through training, certification, dissemination of technical information, and promotion of sound policies to benefit society through protection and enhancement of the water environment.

CWEA is a California Nonprofit Corporation, a Member Association of the Water Environment Federation (WEF), and a member of the National Organization for Competency Assurance (NOCA).

Technical Certification Program History

TCP was created to offer multilevel technical certification for individuals employed in the water quality field. Tests are written by vocational specialists and administered twice yearly in six different disciplines: Collection System Maintenance, Environmental Compliance Inspection, Laboratory Analysis, Plant Maintenance (Electrical/Instrumentation and Mechanical Technologist), Industrial Waste Treatment Plant Operation, and Biosolids Land Application Management.

CWEA first offered a certification program for wastewater treatment plant operators in 1937. The program was administered by CWEA until 1973 when the State of California assumed responsibility. During those 36 years, CWEA awarded 3,915 operator certificates.

The first committees were formed in 1975 to establish a voluntary certification program for water quality professionals specializing in disciplines other than plant operation. The Voluntary Certification Program (VCP) emerged with specialized certificate programs for Collection System Maintenance, Plant Maintenance, Environmental Compliance Inspection, and Laboratory Analysis with certifications first issued in April 1976. In the 1980s, two more disciplines were added: Electrical/Instrumentation and Industrial Waste Treatment Plant Operator.

Today, CWEA offers certification in six vocational programs with a total of 22 individual certifications. About 2,000 applications are processed annually and currently over 5,500 certificates are held by individuals in California and neighboring states.

Certification Process

To become certified, *all applicants* must complete the Application for Technical Certification, pay the application fee, have suitable experience and education, and pass the computer-based test. Application instructions and fee schedules are listed on the application. After applications are received at the CWEA office, applicant information is compiled in a database, and reviewed by CWEA staff and subject matter experts for the respective vocation applied for. If approved, the applicant will receive an eligibility letter. If the application is rejected, the applicant will be notified and asked if warranted to supply more information.

After completion of the computer-based test and grading, applicants are mailed their officicial results letter. Those who pass the exam, are mailed certificates and wallet cards.

Test Administration

Test Dates and Sites

Tests are given throughout the year in California, Michigan, and Alaska (see Application for Technical Certification for test schedule. Applicants who are eligible to take the test will be mailed an acceptance letter with instructions on how to schedule their exam.

Test Site Admission

Certificate candidates are required to show at least one valid government issued photo identification (State driver's license or identification, or passport). Only after positive identification has been made by the testing proctor may a candidate begin the exam. Candidates do not require to show their eligibility letters to enter the test site.

Test Security

All tests are computer-based. No reference material, laptop computers, or cameras are allowed in the test site. Candidates will have access to an on-screen calculator, however, you are welcome to bring your own pre-approved calculator (visit www.cwea.org/cert). Candidates are not allowed to take any notes from the test site. Candidates who violate test site rules may be asked to leave the site and may be disqualified from that test. All violations of test security will be investigated by CWEA and appropriate action will be taken.

Test Rescheduling and Cancellation

To reschedule your application you must submit a written request (a letter stating that you wish to postpone), to postpone to the adjacent testing window. You may only reschedule your application once without a fee. Additional postponent will require a $40 reschedule fee. There are no exceptions to this policy.

To cancel your application you must submit a written request (a letter stating you wish to cancel your application) to CWEA. The written request must be received at the CWEA office no later than two (2) weeks after the approved test window. Full refunds, less the $40 administrative fee, will be made within 4 weeks after the scheduled test date. There are no exceptions to this policy.

If you have a scheduled exam with our testing administrator, Pearson Vue, you must contact them 24 hours in advance to avoid losing your exam fee.

Test Result Notification

Test results are routinely mailed to certificate candidates approximately two weeks after the test date. Results are never given over the phone. All results are confidential and are only released to the certificate candidate.

Issue of Certificate / Wallet Card

Certificates and wallet cards are issued to all candidates who pass the test. Certificates and wallet cards are mailed about two to three weeks after result notifications are mailed.

Certificate Renewal

All certificates are renewed annually. The first renewal is due one year from the last day of the month in which the certification test was held. Certificate renewals less than one year past due are subject to the renewal fee plus a penalty fee of 100 percent of the renewal fee. Certificate holders more than one year past due will need to retest to regain certification. Renewal notices are mailed to certificate holder's two months before the due date. It is the responsibility of certificate holders to ensure the certificate(s) remains valid. Continuing education will be required for renewal after 2001.

Accommodations for Physical or Learning Disabilities

In compliance with the Americans with Disabilities Act, special accommodations will be provided for those individuals who provide CWEA with a physician's certificate, or its equivalent, documenting a physical or psychological disability that may affect an individual's ability to successfully complete the certification test. Written requests for special accommodations must be made with the test application along with all supporting documents of disability.

Test Design and Format

Test Design

All certification tests are designed to test knowledge and abilities required to perform the EsThe Essential Duties and Test Content Areas for each certification were determined by a job analysis and meta-analysis of job specifications by two independent psychometric consulting firms. The studies gathered data from on-site visits of over 31 water and wastewater agencies, interviews with 110 water and wastewater professionals, and analysis of more than

300 job specifications. All research was conducted under the guidance of the TCP Committee, vocational sub-committees, and CWEA staff. All test questions are designed to measure at least one area of knowledge or ability that is required to perform an essential duty.

Test Delivery Mechanism

All tests are computer-based format and are written in the English language only.

Test Format

All TCP tests are in multiple choice format (see the sample test questions in this booklet for an example). The multiple choice format is considered the most effective for use in standardized tests. This objective format allows a greater content coverage for a given amount of testing time and improves competency measurement reliability. Multiple choice questions range in complexity from simple recall of knowledge to the synthesis and evaluation of the subject matter.

Test Pass Point

The basic minimum score required to pass all tests is 75 percent of possible total points. However, the score may be adjusted downward depending on test complexity. It should be assumed that the passing score is 75 percent and candidates should try to score as high as possible on their test (in other words, always try for 100 percent). The pass point for each vocation and grade level is set independently. Also, each version, or form of a test will have its own pass point. Different versions are given each time the certification test is administered.

How Pass Points are Set

A modified *Angoff Method* is used to determine the pass point for each version of each test. The modified *Angoff Method* uses expert judgements to determine the test difficulty. The easier the test, the higher the pass point; similarly the more difficult the test, the lower the pass point.

The following is an outline of the modified *Angoff Method* (some details have been omitted):

1. A group of Subject Matter Experts (SMEs) independently rate each test question within a given test. The ratings are defined as the probability that an acceptably (minimally) competent person with the requisite education and experience will answer the question correctly. An acceptably (minimally) competent person is defined as someone who safely and adequately performs all job functions and requires no further training to do so.
2. The SMEs review each test question as a group. A consensus is reached for the rating of each test question. The SMEs also review comments submitted in writing by test-takers. Any test question that is judged to be ambiguous, has more than one correct answer, or has no correct answers is eliminated from the scoring process for that test. These test questions are then revised for future use, re-classified, or deleted from the test item bank.
3. After the data are refined, the final step is to calculate the mean, or average, of all the test question ratings. This becomes the overall pass point estimation.

Why Use Modified Angoff?

Each version of a given certification test uses questions from a test item bank. Each of these questions vary in difficulty. Because a different mix of questions is used in each test, the overall difficulty level is not fixed. Thus, it is important to make sure that the varying difficulty level is reflected in the pass point of each test to ensure that test results are reliable. Test reliability is concerned with the reproducibility of results for each version of a given test. In other words, for a test to be reliable it must yield the same result (pass or fail) for the same individual under very similar circumstances. For example, imagine taking a certain grade level test and passing it. Immediately after completing this test, a different version of the same grade level test is taken. If the test is reliable, the same result will be achieved: pass. If a passing grade is not achieved, it is likely that the test is not a reliable measure of acceptable (minimal) competency.

By taking into consideration the difficulty of the test, the modified Angoff Method significantly increases the reliability of the test. Also, since each test is adjusted for difficulty level, each test version has the same standard for passing. Thus, test-takers are treated equitably and fairly, even if a different version of the test is taken.

There are other methods for setting pass points. However, for the type of tests administered by CWEA, the modified Angoff Method is the best and most widely used.

Test Scoring

All tests are electronically scored by CWEA. Most test items are valued at one point. Some test items requiring calculations are worth multiple points varying from two to five (possibly more). After tests are scored, total points are compiled and an overall score is calculated as the sum of all points earned on the test. If the overall score is equal to or greater than the established pass point, the candidate has passed the test. Total points possible for each test vary, but the average is 100 points plus or minus 25.

Item Appeals

Item Appeals

Candidates who wish to appeal a specific test item must do so during the test by completing the Candidate Feedback review screen. Candidcate feedbacks will be evaluated and appropriate adjustments made to the test content. Candidates submitting feedback will not be contacted in regards to the appeal.

Qualifying for the Test

Eligibility criteria are summarized in Table 2-1. Candidates may qualify by meeting either Education/Experience Combination A, B, C, or D. If you do not meet any of the combinations of experience and education, then you do not qualify for Grade II.

Table 2-1 Eligibility Criteria for Grade II Environmental Compliance Inspector

Combination	Education and Certificates	+ Experience
A	None	4 full-time years in environmental compliance inspection
B	Hold a Grade I Environmental Compliance Inspector Certificate for 1 year	2 full-time years in environmental compliance inspection
C	Hold an AA/AS degree in a related field	2 full-time years in environmental compliance inspection
D	Hold a BA/BS, or higher, degree in a related field	1 full-time year in environmental compliance inspection

Grade II Environmental Compliance Inspector certification is designed to demonstrate acceptable competency at the skilled or journey level. More specifically, Grade II certification implies competence in the knowledge, skills and abilities required to perform the *Essential Duties* of a skilled or journey level Environmental Compliance Inspector.

Essential Duties

Grade II duties include the essential duties identified in the study guide for Grade I Environmental Compliance Inspector. In addition, the Grade II Environmental Compliance Inspector essential duties include:

- Inspects a variety of pretreatment systems, facilities, and processes of industrial, commercial, residential, and institutional establishments for compliance with federal, state, and local regulations, permit conditions, and reuirements related to pretreatment of industrial wastewater, storm runoff, and pollution prevention.
- Reviews and evaluates all but the most complex permit applications, self-monitoring reports, facility modifications, and pretreatment systems; issues permits following established practices, policies, procedures, internal guidelines, and models; performs calculations related to industrial discharge permitting, including calculation of production-based and alternative limits.
- Initiates appropriate enforcement action after identifying noncompliance with local, state or federal requirments; prepares and issues written notices of requirements and violations of regulations; researches compliance history of facilities; participates in enforcement hearings; and monitors follow-up action.
- Reviews compliance monitoring reports, such as toxic organic management plans, spill prevention control and countermeasures, pollution prevention plans, baseline monitoring reports, 90-day reports, periodic reports of continued compliance, and self-monitoring reports and sample results, for compliance with federal, state, and local requirements.
- Determines sampling locations and methods; collects representative samples of water and wastewater from industrial, commercial, residential, and institutional sources and storm sewers; uses appropriate containers and preservation methods; performs field or laboratory tests on samples collected; observes and records field conditions, meter readings, field test results, and other data relevant to sampling conditions, and completes documentation.
- Investigates and traces sources of illegal or nuisance waste discharges; responds to call-outs; provids technical assistance and guidance; and observes, monitors, and evaluates conditions and initiates appropriate responses.
- Prepares manual and computerized written, oral, tabular and graphic reports, and summarizes requirements and regulations.
- Explains environmental compliance regulations, requirements, and policies to business owners and operators, other government agencies, and the general public.
- Plans and participates in pollution prevention, including commercial business regulation, development of best management practices, and public outreach.
- Analyzes dischargers' activities and prepares data for sewer service charges and capacity fees; researches tenant occupancy uses, sewer service and/or capacity charges and information; reviews and anayzes information for sewer service refunds, making recommendations and providing the supervisor and/or manager with documentation; and responds to inquiries concerning sewer service charges and capacity fees.
- Responds to and initiates contact with system users; provides detailed information on a variety of topics in a clear, succinct manner using the appropriate approach and response for the situation; shares technical and/or specialized information with appropriate staff, industrial users, and other public agencies; and provides feedback, observations, and analysis to appropriate staff.
- Researches and keeps current on pertinent information and development in environmental compliance functional areas; analyzes and implements state, federal or local requirements as necessary to maintain approved pretreatment, pollution prevention, and storm water runoff programs.

- Recognizes and corrects unsafe conditions; understands safety regulations; implements and recommends proper safety protocols.

Section 3

Skill Sets

Grade II Environmental Compliance Inspectors have a wide range of responsibilities. Primary responsibilities include assisting the city, municipality, or regional agency in protecting their wastewater collection and treatment systems, and the health and safety of their workers. Grade II Inspectors are expected to posses acceptable competency when performing the *Essential Duties* of Inspectors described in Section 2 of this study guide. Grade II Inspectors should be able to perform these tasks in any city, municipality, or sanitation district in the United States.

In addition to having mastered the knowledge, skills and abilities required for Grade I Inspectors, Grade II candidates are expected to have a thorough understanding of the subject areas covered in the skill sets outlined below, and must be able to recall and apply principles, ideas, and theories, and to break down ideas and theories into their constituent parts. Inspectors should be very familiar with all federal regulations pertaining to the pretreatment program. Additionally, Inspectors responsibilities are expanding to include monitoring enforcement of storm water pollution prevention and hazardous wastes programs. Grade II candidates should be very familiar with these regulations as they apply to local enforcement.

The following paragraphs describe in more detail the practical skills that candidates must possess to achieve Grade II Environmental Compliance Inspector certification. Table 3-1, presented at the end of this section, cross-references each skill set with a specific chapter, section, and/or page of applicable references to assist the candidate in better understanding the subject matter.

Skill Set 1 Regulations and Permitting

Candidates must be very familiar with the federal regulations that authorize the duties of Grade II Inspectors. These include regulations that deal with water pollution control of indirect dischargers to Publicly Owned Treatment Works (POTW). Increasingly, Inspectors are being called upon to enforce storm water regulations on dischargers. Often an industrial facility will have both direct and indirect dischargers that Inspectors will be responsible for inspecting and enforcing. Candidates should also be familiar with hazardous waste regulations, especially those associated with pretreatment such as disposal of hazardous sludges.

1.1 EPA Pretreatment Regulations and Standards

The heart of the national pretreatment program is a set of rules and regulations known as the General Pretreatment Regulations. These regulations are codified in Title 40 of the Code of Federal Regulations, Part 403 (40 CFR 403). These regulations establish the responsibilities of federal, state, and local governments, industry, and the public to implement the national pretreatment program and regulate the type and quantity of pollutants, which may be discharged to POTW. The General Pretreatment Regulations regulate pollutants which may: 1) pass through the POTW treatment system untreated or partially treated, 2) to interfere with the POTW treatment works, and/or 3) contaminate the POTW sludge with respect to the sludge disposal method employed by the POTW.

Candidates must be able to identify the conventional pollutants that are found in domestic, commercial, or industrial wastes. They must also be able to identify or list the general prohibitions in the general pretreatment regulations, as well as the eight specific categories of pollutants that are generally prohibited from discharge into a POTW.

1.2 Categorical Pretreatment Standards

In addition to the general pretreatment regulations, the EPA has established industrial categorical pretreatment standards to regulate the discharges of wastewaters from certain categories of industrial facilities. These include both direct discharges to the environment and indirect discharges to a POTW. Categorical pretreatment standards apply to specified indirect industrial dischargers to POTW. Two different types of categorical standards are used in the EPA pretreatment program: concentration-based standards and production or mass-based standards.

Inspectors must be very familiar with all of the pretreatment standards contained in 40 CFR Sections 413 through 471. These include industrial categories with concentration-based discharge standards, mass-based standards, and a combination of the two. Inspectors should also understand the combined waste stream formula from 40 CFR 403.6e, and its complication to industries with multiple waste streams from regulated process waste streams, unregulated waste streams, and dilute waste streams.

Categorical pretreatment standards are based on the use of best available technology economically achievable (BAT) or best practicable control technology (BPT). Inspectors should be well acquainted with the treatment technologies used to treat waste streams from each federal category. The largest number of permitted categorical dischargers are under the metal finishing category 40 CFR 433, and Inspectors should be especially well versed in this category and the numerous metal finishing operations that fall under these regulations.

1.3 Water Quality Regulations for Storm Water

Increasingly, Inspectors are taking on the responsibility of monitoring and enforcing water quality regulations for storm water in urban and industrial areas. These regulations fall under EPA's National Pollutant Discharge Elimination System (NPDES) as codified in 40 CFR 122. Storm water quality regulations include monitoring and discharge requirements for certain specified facilities and industrial categories, including POTW. California NPDES General Permits for dischargers of storm water associated with industrial activities include all categorical industries under 40 CFR Subchapter N subject to storm water effluent guidelines. The General Permit also covers regulations of certain manufacturing facilities if they have polluting materials exposed to storm water runoff.

Industries that fall under the EPA's pretreatment program may also have activities that fall under the storm water quality program. Inspectors should become familiar with the Federal Storm Water Quality Regulations including state, regional, and local storm water regulations based on this federal code. These can include general NPDES storm water discharge permits for industrial activities under which certain industries and manufacturing facilities are regulated. Requirements may include the implementation of best management practices (BMP) and other methods of pollution prevention.

1.4 Permits and Reports

Inspectors should be very familiar with the industrial waste pretreatment permitting program, including the authority and the procedures for the issuing of industrial wastewater discharge permits to industrial users by the local control authority. They should also be familiar with the reporting requirements associated with the industrial wastewater discharge permit process, including the baseline monitoring report (BMR), final compliance report, and periodic compliance reports or self-monitoring reports.

Inspectors should be familiar with the reporting procedures and documents associated with enforcement of pretreatment regulations on discharge violators. These include warnings and notices of violation, and administrative orders that may be used by the control authority to enforce actions against violators, such as consent, compliance, or cease and desist orders.

Inspectors should also understand the definitions of significant non-compliance as outlined in the General Pretreatment Regulations in 40 CFR 403, and understand the enforcement actions available and/or required by the control authority when dealing with increasing levels of non-compliance.

Skill Set 2 Environmental Monitoring and Sampling Techniques

As part of their duties, Grade II Inspectors will inspect a large variety of industrial effluent monitoring equipment including pH, selective ion, and oxidation reduction potential (ORP) probes, meters, recorders, and control systems; flow meters, recorders, and totalizers; and explosivity meters. Furthermore, they must be well trained and knowledgeable in collecting representative samples of water and wastewater from industrial, commercial, residential, and institutional sources and storm sewers. They should be able to determine proper sample locations, proper sampling methods, sample handling, and documentation.

2.1 Flow Monitoring and Sampling Technology and Equipment

Grade II Inspectors will either be inspecting or directly using a wide variety of industrial wastewater flow monitoring equipment. Candidates should have a thorough knowledge of flow monitoring equipment theory and principals and be able to inspect and assess flow monitoring installations for proper construction, operation, and maintenance. These include open channel flow measuring devices such as weirs and flumes, and closed pipe systems that use positive displacement devices or various velocity measuring devices such as magnetic and ultrasonic meters and differential pressure.

In addition to flow meters, Inspectors should also be familiar with the process monitoring instruments commonly used in pretreatment systems, such as pH and ORP probes and controllers, and should know how these instruments are used to control chemical feed systems and sampling equipment.

2.2 Wastewater Sampling Equipment

Inspectors must be thoroughly knowledgeable about the various wastewater sampling methods and equipment used by their control authority (POTW) and the industrial users they permit and inspect. In addition to understanding the grab sample, time composite, and flow composite methods widely used for routine sampling, Grade II Inspectors should be familiar with and understand the operating principles of the automatic flow proportional sampling devices that are often required by many control authorities. These include contact closure devices for signaling an automatic sampler to sample at fixed-volume intervals to obtain a flow-proportional composite sample.

Grade II Inspectors should be familiar with non-routine sampling procedures and protocol, such as those involved with industrial user violation sampling and investigating or tracing illegal discharges into the POTW collection system. These include upstream and downstream surveillance sampling and the methods to determine whether or not an illegal discharge is occurring or has occurred.

2.3 Sample Preservation Procedures

The importance of proper sample preservation, storage, and transport, for both routine and non-routine sampling, cannot be over emphasized. A great deal of time and expense expended in sampling programs can be wasted if samples are mishandled, resulting in erroneous laboratory analytical results. Inspectors must be very familiar with the proper type and size of containers, the preservation techniques, and the chemicals and holding times associated with the parameters commonly analyzed for POTW collection systems and in the pretreatment program.

It is also useful to have an understanding of what the various preservatives do for the types of analyses to be performed. For example, acid is often used for certain types of heavy metal analyses to keep metals dissolved and prevent absorption on the sides of the storage vessel. For oil and grease samples, acid is used to break or prevent emulsification, which could hinder complete extraction of these compounds during the analysis process. The EPA-published a list of preservation methods and allowable storage times for samples used in monitoring NPDES discharges can be found in 40 CFR Part 136.3 (e).

Grade II Inspectors should be familiar with the special sampling and sample handling procedures required for total toxic organics (TTO) analyses. TTO are divided into two major subgroups: volatile and nonvolatile compounds. Volatile compounds (benzene, carbon tetrachloride, vinyl chloride, methyl chloride) will escape from samples that are exposed to the atmosphere, so they must be collected in a manner that will prevent contact with air (zero headspace). When collecting nonvolatile toxic organic samples, special care must be taken to ensure that the sampling equipment is not manufactured with materials that will contaminate the sample.

2.4 Documentation

Inspectors can never know in advance which sample or sample report may become critical evidence in POTW enforcement actions against an industrial user. Inspectors must understand the major differences between civil and criminal actions and the level of evidence required for successful prosecution. Inspectors must be familiar with the sampling procedures and protocol used to ensure that evidence admissible in enforcement proceedings is collected. These include the proper use of field reports, maintaining chain-of-custody for all samples, the use of evidence tape, etc.

Routine and non-routine monitoring of reports must be done to ensure that they contain all of the information necessary for court testimony, if required.

Skill Set 3 Wastewater Collection and Treatment

Grade II Inspectors must have a journey-level knowledge of standard scientific and engineering principles used in the design and operation of POTW and their collection systems. To effectively manage and enforce the local pretreatment, storm water, and pollution prevention programs, Inspectors must also understand the impacts of industrial wastes and non-point sources of pollution, such as storm water runoff, on these systems.

3.1 Collection Systems

Grade II Inspectors should have a working knowledge of:

- Plumbing codes for water distribution and sanitary sewer systems, including backflow prevention requirements;
- Principles of gravity flow in sanitary sewers;
- Layout and design principles of typical municipal wastewater collection systems;
- Function, design principles, and operation of sewer lift stations;
- Problems associated with sewage collection systems, including sedimentation clogging, grease build-up, generation of hydrogen sulfide gas, and storm water and ground water intrusion.

3.2 Wastewater Treatment

Grade II Inspectors are responsible for the protection of the POTW treatment systems from upsets that can be caused by industrial or illegal discharges within the collection system. This requires a working knowledge of the principles and common methods used for wastewater and sludge treatment within POTW. Candidates' knowledge requirements include the following treatment categories:

- **Preliminary Wastewater Treatment,** including wastewater screening, comminution, grit removal, and flow equalization.
- **Primary Treatment** to remove suspended and floatable solids from wastewater prior to secondary treatment, including chemical coagulation, primary sedimentation, flotation, and in some cases, fine screening.
- **Secondary Treatment** (usually biological treatment) for the purpose of biochemical oxygen demand (BOD) reduction, including reduction of both organic or carbonaceous BOD and nitrogenous BOD. Biological treatment includes trickling filters or other biomedia type filters, rotating biological contactors (RBC), activated sludge treatment with its many variations, aerated and facultative lagoons, and secondary sedimentation.

- **Tertiary Treatment,** including advanced methods to remove fine suspended solids and other contaminants, chemical coagulation, and various filtration systems. Wastewater effluent used for reclamation purposes may undergo further treatment to remove suspended or even dissolved solids through the use of membrane type filter systems.
- **Disinfection** using chlorination systems, ozonation, or other methods before disposal of treated wastewater to reduce bacteria, pathogens and other microorganisms. Treated effluent that is to be reused or reclaimed may have more stringent disinfection requirements than effluent which is discharged to surface waters or the ocean under NPDES permit.

3.3 Sludge Treatment and Disposal

Solids generated within a POTW, including primary sludges and secondary biosolids, are usually treated to reduce their volatile content and pathogen levels, and to stabilize the solids for disposal. Inspectors should be familiar with the sludge treatment methods, including aerobic and anaerobic digestion, thickening, composting, thermal reduction, and others. Treated sludges are then normally dewatered to reduce their volume before disposal. Methods include the use of centrifuges, belt filters, vacuum filters, and sludge filtering/drying beds.

Disposal methods for stabilized and dewatered sludge include landfill and land application. Most municipal sludges are disposed of by land application as soil amendments and agricultural operations. This method of disposal is subject to federal land application regulations under 40 CFR 503.

Grade II candidates must understand how the land application regulations impose limits on industrial pollutants, especially heavy metals, that can be accepted by a POTW. Sludge quality limits are often the most stringent factor involved in determining POTW local limits for industrial discharges.

Skill Set 4 Safety

To successfully achieve a Grade II certification, Inspectors should have the ability to recognize and identify hazards and hazardous situations encountered above and below ground in collection systems and industrial operations. A full knowledge of safety procedures, prevention techniques, and worker right-to-know laws is also needed.

Grade II candidates must know how to apply safety regulations, procedures and practices to conditions encountered during inspections and traffic control, and how to use personal protective equipment (PPE).

4.1 Traffic Control

It is necessary to be familiar with and understand the elements of traffic control. Grade II Inspectors should be able to develop and interpret traffic control plans for working in roadways and understand the proper traffic control elements and equipment used for lane closures on single-lane and multiple-lane highways.

4.2 Confined Space Entry

Grade II candidates should be able to distinguish the different classifications of confined spaces and the types of hazards associated with them. The Occupational Safety and Health Act (OSHA) regulations require entry permits for many types of confined space work. Inspectors should be able to identify a permit-required confined space, prepare the entry permit, select the proper equipment and procedures, and serve as the entry supervisor.

4.3 Chemical and Biological Hazards

There are numerous chemical and biological hazards within the industrial environmental compliance inspection field that may be encountered on a daily basis. A basic knowledge of these substances, and understanding their potential for hazard should be obtained. Inspectors should be knowledgeable about the policies and procedures for prevention of and protection from these hazards. The ability to understand and identify the types of PPE and their proper use is important.

4.4 Hazardous Gases

Inspectors should be able to identify the various types of hazardous gases that may be encountered in inspection work, including hydrogen sulfide, hydrogen cyanide, and others. They must also be knowledgeable about the methods and equipment used for toxic gas detection.

4.5 Material Safety Data Sheets (MSDS)

MSDS provide valuable information about potentially hazardous chemicals used on the job. Inspectors should be able to interpret MSDS and identify the hazards, and PPE required for safe handling or emergency response. Inspectors can be considered first responders in hazardous material emergencies during inspection work.

Skill Set 5 Applied Scientific Principles

Grade II Inspectors are expected to expand on their knowledge of Grade I level chemistry and mathematics and be able to apply the theories to solving real-life problems encountered in industrial inspections. Grade II candidates are expected to know more complex arithmetic including the use of logarithms. Inspectors are also required to know basic mechanical, hydraulic and environmental engineering principles and concepts.

5.1 Chemistry

Grade II candidates should be able to solve chemistry problems associated with wastewater chemistry and problems commonly encountered in industrial processes and industrial pretreatment systems. These include applied problems such as pH neutralization, alkaline and sulfide precipitation of heavy metals, cyanide oxidation, and hexavalent chromium reduction, among others.

5.2 Applied Mathematics

Inspectors must be able to apply their knowledge of arithmetic, including fractions, decimals, proportions, percentages, and logarithmic notation to problems encountered in wastewater treatment, pretreatment inspection and compliance work, and industrial pretreatment. These include problems regarding spill containment, composite sampling, mass emission rates, waste strength monitoring, and calculation of sewer use fees.

Skill Set 6 Industrial Processes and Pretreatment

Grade II Inspectors must be very familiar with the industrial processes and wastewater pretreatment systems they will be inspecting. Additionally, Inspectors should be able to read and understand technical information, submitted to them by industrial users, relating to wastewater generation, treatment, and disposal, including engineering drawings and schematics that may be included with industrial wastewater discharge applications and compliance actions. They must also be familiar with basic mechanical, hydraulic, and environmental engineering principles and concepts as they apply to pretreatment inspection work.

6.1 Industrial Wastewaters

Grade II Inspectors must be knowledgeable about industrial wastewaters and the manufacturing processes that generate them. Particular attention should be paid to the manufacturing processes subject to federal pretreatment standards that have been promulgated under 40 CFR, Subchapter N. These include metal finishing and printed circuit board manufacturing industries, pulp and paper industries, battery manufacturing, petroleum refining, iron and steel industries, and inorganic chemical industries, among others. Grade II candidates should also be familiar with the wastewater-generating manufacturing processes associated with significant non-categorical dischargers such as high volume or high strength waste from food processing industries.

6.2 Industrial Pretreatment Technologies

Categorical pretreatment standards are based on levels of pollutant discharge that can be achieved by pretreatment of categorical wastewaters using best practicable control technology (BPT) or best available technology economically achievable (BAT). Grade II candidates should become familiar with the standard pretreatment systems and processes used for each federal category. These can be found in the Water Environment Federation (WEF) manuals of practice as well as the development documents for the federal pretreatment standards in 40 CFR, Chapter I, Subchapter N.

A good working knowledge of these pretreatment technologies and their capabilities and limitations is necessary in order for Inspectors to assess industrial users' systems for the equal or equivalent pretreatment performance expected under federal law. This knowledge will also assist Inspectors in assessing the ability of pretreatment systems to meet local limits, which can be more stringent than federal categorical limits.

In addition, standard pretreatment and control technologies may include source control procedures, methods, or processes used within the manufacturing process itself to modify, minimize, or otherwise control the wastes that will have to be treated.

Inspectors should be familiar with physical treatment such as equalization, screening, sedimentation, flotation, filtration, evaporation, absorption, and air stripping. Chemical treatment technologies include pH neutralization, precipitation, ion exchange, oxidation, reduction, and disinfection treatment. Biological pretreatment methods include methods similar to those discussed under Skill Set 3. High strength wastewaters (high BOD), such as those from the dairy and meat-packing industries, are often treated by anaerobic digestion followed by aerobic treatment.

Inspectors should also be familiar with the technologies used for solids or residuals management from pretreatment systems. These include sludge concentration or thickening, digestion, dewatering or drying, heat treatment or incineration, and stabilization and solidification. Solid residues from pretreatment systems are often considered hazardous wastes and must be properly disposed of in accordance with federal and local hazardous waste regulations.

6.3 Pollution Prevention Principles

There is an increasing emphasis on pollution prevention within regulated industries to minimize the volume or strength of waste that requires pretreatment as well as the residual solids that may be generated for disposal. Some advanced pollution prevention technologies and methods may actually be requirements for certain industries to meet stringent pretreatment standards associated with their federal categories. An example would be closed loop electrolytic recovery systems for cadmium plating rinse water to achieve zero discharge to meet the pretreatment standards for new source cadmium limitations under the metal finishing standards. Grade II candidates should be familiar with the more commonly used pollution prevention methods and technologies for specific industries as published in the WEF manuals of practice and other reference material provided in Section 6.

Skill Set 7 Storm Water Quality

Grade II Inspectors should be familiar with the industrial activities that could impact storm water runoff, particularly from industrial dischargers that they will typically be inspecting under the pretreatment program.

The State of California NPDES General Permit for storm water dischargers associated with industrial activities covers many of the industries that are also subject to federal categorical pretreatment standards. Grade II Inspectors should become familiar with industrial activities that can cause or be a source of storm water pollution, including outdoor storage and waste piles, feed stock and waste storage areas that may be spill-contained but uncovered, and other activities that can result in either non-storm water discharges to storm drains or contact by rainfall or rainfall runoff with polluting materials. These outdoor activities are specifically mentioned for federal categories covered by storm water effluent guidelines in 40 CFR, Chapter I, Subchapter D.

Table 3-1 Grade II Environmental Compliance Inspector							
		Primary References[a]					
No.	**Skill Set**	**Developing Source Control Programs for Commercial and Industrial Wastewater**	**Industrial User Inspection and Sampling Manual for POTWs**	**Pretreatment Facility Inspection: A Field Study Training Program**	**Industrial Waste Treatment, Volumes I and II**	**Treatment of Metal Wastestreams**	**Pretreatment of Industrial Wastes**
1	**Regulations and Permitting**						
1.0	General	Chapter 1, pgs. 5–10 Chapters 2 and 5	Chapter I, pgs. viii–xvi	Chapters 1 and 3	Volume I, Chapter 3		Chapters 1 and 2
2	**Environmental Monitoring and Sampling Techniques**						
2.0	General	Chapters 9–11	Chapter III, Appendix VI	Chapters 6–7	Volume I, Chapters 2 and 6	Section 7	Chapter 3
3	**Wastewater Collection and Treatment**						
3.0	General				Volume II, Chapter 2 Glossary	Section 4	
4	**Safety**						
4.0	General	Chapter 13	Chapter 11	Chapter 5	Volume II, Chapter 2 Glossary	Section 4	
5	**Applied Scientific Principles**						
5.0	General			Appendix II, A–T		Appendices II and III	
6	**Industrial Processes and Pretreatment**						
6.0	General	Chapters 4 and 12	Appendix II	Chapters 8 and 9	Volume I, Chapters 5 and 7–11	Sections 5 and 6	Chapters 3–10

a. Complete reference information given in Section 6.

Section 4

Test Preparation

This section provides tips on the how candidates should prepare for the test, information on the test question format and the math skills likely to be needed, and a table of equivalents and formulas.

Basic Study Strategy

To prepare adequately for the test, candidates need to employ discipline and develop good study habits. Ample time to prepare for the test should be allowed. Candidates should establish a study schedule and stick to it. One or two nights a week for one or two months should be sufficient in most cases. Spend one or more hours studying in quiet surroundings or in small groups of two or three serious candidates. Efforts should be directed to the test subject areas that are not being performed on a day-to-day basis.

It is especially important for candidates to obtain access to the reference materials listed under the Primary References heading in Section 6 of this study guide. Many of these materials are likely to be available in the work place and in technical libraries. Some references, such as codes and regulations, are available on-line as well. For a list of links to on-line resources, see the Certification Resource Links page on the CWEA website at www.cwea.org/tcp/resources.

Candidates should study at the certification level being sought after. There is no advantage to spending time studying material that will not be on the test. Refer to Section 3 of this study guide for topics that will be covered.

While using this study guide, be sure to understand the answers to all the sample and diagnostic test questions. It may also be helpful to use the skill set descriptions in Section 3 to devise additional questions for further study. Discuss the questions with others. Not only is this a good study technique, it is also an excellent way to learn.

It is not necessary, but it can certainly be helpful, to memorize all the formulas and equivalents used in working out the solutions for questions involving calculations. Table 4-1 lists many, but not all, of these formulas and conversion factors. When the test is administered, a sheet listing some, but not all, of the relevant formulas and equivalents will be provided as part of the test materials. So that candidates may determine which formulas and equivalents will actually be on the sheet included with the test booklet, copies of these sheets are provided on the CWEA website at www.cwea.org/tcp/resources. (The set of equivalents and formulas on the sheet provided with the test may not be exactly the same as the set included in Table 4-1.)

Multiple Choice Questions

All test questions are written in multiple-choice format. At first glance, the multiple-choice problem may seem easy to solve because so much information is given, but that is where the problem lies. The best answer must be chosen from the information provided. Here are some tips that may help solve multiple-choice problems.

1. Read the question completely and closely to determine what is being asked.

2. Read all the choices before selecting an answer.

3. Look for key words or phrases that often, but not always, tip off correct or incorrect answers:

Absolute Words

(Suspect as a wrong choice)

Always	Never	None
Totally	All	

Limiting Words

(Often a correct choice)

Few	Occasionally
Some	Generally
Often	Usually
Many	Possible

Table 4-1 Environmental Compliance Inspector

Equivalents and Formulas

3.785 Liters/gallon

8.34 lbs/gallon

7.48 gallons/ft^3

43,560 ft^2/acre

453.6 gm/lb

28.35 gm/oz

12 inches/ft

$\pi = 3.14$

Area

circle = $\pi \times R^2$

trapezoid = $\frac{(B + b)}{2} \times H$

triangle = $\frac{b \times h}{2}$

Volume

rectangular solid = L x W x H

cylinder = $\pi \times R^2 \times H$

Manning Formula

$$Q = \frac{1.49 \times A \times R^{2/3} \times S^{1/2}}{N}$$

where R = Hydraulic Radius
S = Slope
N = Friction Factor
A = Area of Flow

Periodic Properties of Elements

Element	Symbol	Atomic Number	Atomic Weight (grams/mole)
Hydrogen	H	1	1.0
Carbon	C	6	12.0
Nitrogen	N	7	14.0
Oxygen	O	8	16.0
Flourine	F	9	19.0
Sodium	Na	11	23.0
Magnesium	Mg	12	24.3
Aluminum	Al	13	27.0
Phosphorus	P	15	31.0
Sulfur	S	16	32.1
Chlorine	Cl	17	35.5
Potassium	K	19	39.1
Calcium	Ca	20	40.1
Chromium	Cr	24	52.0
Iron	Fe	26	55.8
Nickel	Ni	28	58.7
Copper	Cu	29	63.5
Zinc	Zn	30	65.4
Arsenic	As	33	74.9
Silver	Ag	47	107.9
Cadmium	Cd	48	112.4

4. Never make a choice based on the frequency of previous answers. If the last ten questions have not had a "b" answer, don't arbitrarily select "b". Instead use logic and reasoning to increase the chances of choosing the best answer.
5. Reject answers that are obviously incorrect and choose from the remaining answers.

   Example

   The straight line distance from the center of a circle to the outer edge is called the:

   a. diameter
   b. circumference
   c. chord
   d. radius

   It is possible to reason out the answer by having some knowledge of geometry and studying the questions and the four provided answers. The question is asking for the name of a line or distance that is inside of the circle. Circumference is the distance around the outside of the circle, so this is an obvious incorrect answer.
6. Make an educated guess.

   Never reconsider a choice that has already been eliminated. This means that answer "b" should not be considered. Look for key phrases or words that give a clue to the right answer. Chord, answer "c," chord refers to a straight line inside of the circle, but it does not necessarily go through the center of the circle, so this answer can be eliminated.

   Answers "a" and "d" are distances that are measured as straight lines and either start or go through the center of a circle. The diameter goes through the center rather than starting from the center. Radius, answer "d" is the correct answer and is defined as the straight line distance from the center to the outer edge of a circle.
7. Skip over questions that are troublesome. Mark these questions for later review.
8. When finished with the test, return to the questions skipped. Now think! Make inferences. With a little thought and the information given, the correct answer can be reasoned out.
9. Under no circumstances leave any question unanswered. There is no penalty for incorrect answers. However, credit is given only for correct answers.

   NO ANSWER=WRONG ANSWER
10. Keep a steady pace. Check the time periodically.
11. Remember to read all questions carefully. They are not intended to be "trick questions"; however, the intent is to test candidates' knowledge of and ability to understand the written language of this profession.

Math Problems

Math problems on the certification tests are meant to reflect the type of work encountered in Plant Maintenance E/I Technology. Although there is no specific math section on the test, many questions will require some calculations such as area, volume, ratios, and conversion of units. By far, the greatest number of applicants who fail the certification tests do so by failing to complete the math problems. Completing the math problems will be greatly simplified by using a calculator and the approach suggested in the following paragraphs.

Calculators

A scientific calculator may be used during the test; however, a four-function (add, subtract, multiply and divide) calculator is adequate for completing any of the certification tests. Additional functions (e.g., square root) are not necessary, but may be helpful in some situations. The most important factor in effectively using a calculator is the candidate's familiarity with its use prior to the time of the examination. Confidence in the calculator and a full understanding of how to properly operate it are a must. The best way to gain confidence is to obtain the calculator early and use it frequently.

Completing the sample problems in this section as well as the diagnostic test in Section 5 will improve proficiency. Additional use will also help. For example, calculate the gas mileage when filling a vehicle's tank. Check the sales tax calculation on each purchase. Balance a checkbook, or check a paycheck. The calculator chosen should have large enough keys so that the wrong keys are not accidentally punched. Be certain there are new batteries in the calculator, or use a solar powered calculator with battery backup.

Approach

The solution to any problem requires understanding of the information given, understanding of what is being requested, and proper application of the information, along with the appropriate equations to obtain an answer. Any math problem can be organized as follows:

Given or Known
All information provided in the problem statement that will be used to get the correct answer.

Find
A description of the answer that is being requested.

Sketch
If possible, sketch the situation described in the problem statement showing size and shape (dimensions).

Equation
A listing of the equation or equations that will be used to generate the answer.

Assumption(s)
Stated assumptions of key information needed to answer a math problem with missing information. This occurs frequently on higher-grade tests.

Answer
This is where the answer is clearly identified.

Advantages to using this approach to organize math problems are that it helps to organize thoughts, breaks the problem solution into a series of smaller steps, and reduces chances of making errors.

Solutions

Solutions to math problems are like driving routes from Los Angeles to San Francisco: there are many different routes that can be taken. Some routes are shorter or less complicated than others. Only certain routes end up in San Francisco.

Solutions to sample problems given in this study guide are the most common solutions. If a different solution arrives at the correct answer, then it can be used as well.

Equivalents and Formulas

Familiarity with the equivalents (conversion factors) and formulas in Table 4-1 is important. Pay special attention to the units of measure that are used in the formulas. A correct answer will not be obtained unless the correct units of measure are used.

Check the units, arithmetic, and answer so that:

1. the units agree;
2. the answer is the same when the arithmetic is repeated; and
3. the answer is reasonable and makes sense.

Dimensional Analysis

When setting up an equation to solve a math problem, the trick is to have clearly in mind what units the answer should be in. Once the units have been determined, work backwards using the facts given and the conversion factors known or given. This is known as dimensional analysis, using conversion factors and units to derive the correct answer.

Remember, multiplying conversion factors can be likened to multiplying fractions. The denominator (the number on the bottom of the fraction) and the numerator (the number on the top of the fraction) cancel each other out if they are the same, leaving the units being sought after.

Example

If a company runs a discharge pump rated at 50 gallons per minute all day, every day for a year, what is the discharge for the year in millions of gallons per year (MGY)?

Given: pump rating = $50 \frac{\text{gal}}{\text{min}}$

Find: discharge = __?__ MGY

Calculations
Convert gal/min to million gal/yr, convert gallons to million gallons, and minutes to years.

What is known about minutes and years? There are 60 minutes in an hour, 24 hours in a day, and 365 days in a year. Put that into an equation, and multiply each conversion factor so the unneeded units are cancelled out:

$$50 \frac{\cancel{\text{gal}}}{\cancel{\text{min}}} \times 60 \frac{\cancel{\text{min}}}{\cancel{\text{hr}}} \times 24 \frac{\cancel{\text{hr}}}{\cancel{\text{day}}} \times 365 \frac{\cancel{\text{days}}}{\text{yr}} \times 1 \frac{\text{MG}}{1{,}000{,}000 \cancel{\text{gal}}} = 26.28 \text{ MGY}$$

Sample Questions

The following sample math problems are intended to demonstrate unit conversion techniques. Although they are general wastewater problems, the questions may not be specific to any vocation.

1. How many gallons of water will it take to fill a 3 cubic foot container?

   $3 \cancel{\text{cubic feet}} \times 7.48 \frac{\text{gallons}}{\cancel{\text{cubic feet}}} = 22.4 \text{ gallons}$

2. If a gallon of gasoline weighs 7.0 pounds, what would be the weight of a 350 gallon tank full of gasoline?

   $350 \cancel{\text{gallons}} \times 7.0 \frac{\text{pounds}}{\cancel{\text{gallon}}} = 2{,}450 \text{ pounds}$

3. The rated capacity of a pump is 500 gallons per minute (GPM). Convert this capacity to million gallons per day (MGD).

   $500 \cancel{\text{GPM}} \times 1 \frac{\text{MGD}}{694 \cancel{\text{GPM}}} = 0.72 \text{ MGD}$

4. A chemical feed pump is calibrated to deliver 50 gallons per day (GPD). What is the calibrated chemical feed in gallons per minute (GPM)?

   $\frac{50 \text{ gal}}{\cancel{\text{day}}} \times \frac{1 \cancel{\text{day}}}{24 \cancel{\text{hr}}} \times \frac{1 \cancel{\text{hr}}}{60 \text{ min}} = 0.035 \text{ GPM}$

5. A chemical feed pump delivers 50 mL per minute (mL/min). Determine the chemical feed in gallons per day (gpd).

   $\frac{50 \cancel{\text{mL}}}{\cancel{\text{min}}} \times \frac{1 \cancel{\text{L}}}{1000 \cancel{\text{mL}}} \times \frac{1 \text{ gallon}}{3.785 \cancel{\text{L}}} \times \frac{60 \cancel{\text{min}}}{\cancel{\text{hr}}} \times \frac{24 \cancel{\text{hr}}}{\text{day}}$

   =19 GPD

6. A cyanide destruction process is designed to treat 30 pounds of cyanide per 24-hour operational day. How many pounds of cyanide can be treated during an 8-hour shift?

   $\frac{30 \text{ lbs CN}}{\cancel{\text{day}}} \times \frac{8 \cancel{\text{hr}}}{\text{shift}} \times \frac{1 \cancel{\text{day}}}{24 \cancel{\text{hr}}} = 10 \text{ lbs CN/shift}$

Math Skills

Grade II candidates must be skilled in arithmetic, basic algebra, and geometry. Candidates must be able to apply these skills to make calculations for work-related tasks such as proportions, averages, volumes, concentrations, determining flow rates, converting from volume to mass, and any other job-related math task that may fall within the skill sets listed in Section 3.

A thorough review of the types of mathematics required for the test is beyond the scope of this study guide. Consult an appropriate math text (see Section 6, References) if there is unfamiliarity with any specific math skill. Appendix A provides general strategies for approaching math problems and math anxiety, as well as resources for remedial study. Below are some examples of the types of math problems that a candidate should be able to quickly solve.

Arithmetic

Candidates should be able to understand and perform the following calculations, either manually or with a calculator:

1. Addition and subtraction of whole numbers, fractions, and decimals.
2. Multiplication and division of whole numbers, fractions, and decimals.

Algebra

Candidates should be able to perform basic applied algebra calculations, such as solving for one unknown in one equation.

Example

An industrial discharger has a wastewater flow of 15,000 gallons per day containing 3.8 mg/L of zinc. What is the mass emission rate in pounds per day?

First convert gallons per day to million gallons per day:

$\frac{15{,}000 \text{ gal}}{\text{day}} \times \frac{\text{MG}}{1{,}000{,}000 \text{ gal}} = 0.015 \text{ MGD}$

Next, use the formula to convert flow and concentration into mass:

Mass = Flow x Concentration x 8.34

where mass is in pounds per day; flow is in million gallons per day (MGD); concentration is in milligrams per liter (mg/L).

0.015 MGD x 3.8 mg/L x 8.34 = 0.48 lbs/day

Geometry

Candidates should be able to calculate circumference, find the area of a rectangle or circle, and find the volumes of rectangular and cylindrical solids. Be prepared to apply these basic skills to work-related problems.

Example

A chemical storage tank 20 feet in diameter and 12 feet, 6 inches tall sits on a rectangular spill-containment pad with concrete walls. The containment pad is 35 feet long by 25 feet wide. How high must the containment walls be, in feet, to provide 100 percent containment of the tank's contents?

This problem requires the ability to calculate the volume of one solid body, the tank, and calculate one dimension of another solid body, the spill-containment pad, to provide the same volume as the tank.

The tank is a cylinder and its volume can be calculated using the volume formula from Table 4-1.

$\text{Vol} = \pi \times R^2 \times H$

where $\pi = 3.14$

$R = \frac{\text{diameter}}{2} = 10 \text{ ft}$

$H = 12.5 \text{ ft}$

To provide the answer in feet, volume should be calculated in cubic feet or ft^3.

$\text{Vol} = 3.14 \times (10 \text{ ft})^2 \times 12.5 \text{ ft} = 3{,}925 \text{ ft}^3$

The volume of a rectangular solid body is given as:

$\text{Vol} = L \times W \times H$

where $L = 35$ ft

$W = 25$ ft

Dimension H, the wall height, is the unknown. Substitute the known values into the equation and solve for H.

$$H = \frac{\text{Vol}}{LW} = \frac{3{,}925 \text{ cubic feet}}{35 \text{ ft} \times 25 \text{ ft}}$$

H = 4.5 feet or 4 feet, 6 inches

This problem requires application of knowledge of basic geometry, arithmetic, and the ability to convert dimensions and units. In this case, three-dimensional (volume, ft^3) converted to one-dimensional (height, ft). It also requires basic knowledge of spill containment requirements. For example, if the tank leaks, the tank volume below the top of the spill-containment wall can be included in the total spill-containment volume.

Section 5

Diagnostic Test

Introduction

This section provides a diagnostic test to assist those studying for the Grade II Environmental Compliance Inspector certification test in evaluating their current level of knowledge in the skill sets outlined in Section 3.

The example questions in the diagnostic test represent the type of knowledge that may be required to successfully pass the certification test. They are based on information contained in Section 6, References, and are arranged according to the skill sets presented in Section 3. However, passing the diagnostic test does not guarantee passing the certification test.

Diagnostic test answers, the applicable skill sets, and selected solutions are presented at the end of this section. Candidates should take the diagnostic test, mark wrong answers, and record the skill sets for questions missed. Using Table 3-1, candidates should review the references to improve their knowledge of the subjects, especially in areas where they answered diagnostic test questions incorrectly.

Skill Set 1 Regulations and Permitting

1. Which one of the industrial operations below falls under the primary operation covered by the metal finishing category in 40 CFR 433?

   a. Electrochemical machining

   b. Vapor plating

   c. Chemical etching

   d. Semiconductor manufacturing

2. A POTW must retain Industrial User records for a minimum of:

   a. 2 years

   b. 3 years

   c. 5 years

   d. 10 years

3. The Federal Act that introduced the concept of cradle to grave manifesting for hazardous waste products is:

   a. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

   b. Superfund Amendments and Reauthorization Act (SARA).

   c. Toxic Substances Control Act (TSCA).

   d. Resource Conservation and Recovery Act (RCRA).

4. Waste discharge regulations can be concentration- or mass-based except for:

   a. sodium and sulfate.

   b. total toxic organics.

   c. pH and temperature.

   d. cyanide.

5. New Categorical Dischargers must submit a Baseline Monitoring Report to the POTW control authority prior to the planned commencement of discharge by at least:
   a. 45 days
   b. 90 days
   c. 180 days
   d. 360 days

6. The State NPDES General Permit for storm water from Industrial Activities covers industries subject to federal storm water effluent limitation guidelines under 40 CFR, Subchapter N. Which of the following industries falls under this category?
   a. Auto wrecking yard
   b. Truck terminal
   c. Cattle feedlot
   d. Paper mill

Skill Set 2 Environmental Monitoring and Sampling Techniques

1. In open channel flow measurement, the term "primary element" is used to denote the:
   a. element that measures the depth of water in the channel.
   b. main control panel.
   c. measuring structure that contains the water.
   d. element that converts depth measurement to flow rate.

2. You want to measure the flow in an 8-inch diameter city sewer line. If you use the Manning formula, what additional data will you need to gather to calculate the flow rate in the downstream manhole?
   a. Pipe length, invert elevation at both ends, water depth at downstream end, and pipe roughness coefficient.
   b. Pipe slope, hydraulic radius and pipe roughness coefficient.
   c. Pipe slope, water velocity at downstream end, and pipe roughness coefficient.
   d. Pipe length, water depth at downstream end, and pipe roughness coefficient.

3. Why are septum vials used for TTO samples?
   a. To prevent skin contact with toxic organic compounds
   b. To prevent cross contamination of grab samples
   c. To prevent sample contact with air
   d. To comply with hazardous waste regulations

4. Civil court rulings are based on whether or not the prosecution proves their case:
   a. beyond a reasonable doubt.
   b. based on the preponderance of evidence.
   c. based on eyewitnesses.
   d. based on hard evidence.

5. A contact-closure device on a flow meter signals an automatic sampler to:
   a. take samples at fixed time intervals.
   b. take samples at fixed volumes.
   c. increase or decrease sample volume in proportion to the flow.
   d. increase or decrease sample frequency in proportion to the flow.

Skill Set 3 Wastewater Collection and Treatment

1. Which of the following is a suspended growth biological treatment system?
   a. Contact stabilization
   b. Step-feed aeration
   c. Trickling filter
   d. Activated sludge

2. Mixed Liquor Suspended Solids (MLSS) is the:
   a. amount of solids removed from the activated sludge reactor.
   b. mixture of wastewater and microorganisms returned to the head of the aeration tank.
   c. underflow from the secondary sedimentation tank.
   d. mass of microorganisms and other solids in the activated sludge reactor.

3. Activated sludge is wasted from the reactor to:
   a. remove excess build-up of solids.
   b. control the sludge age.
   c. return to the primary clarifier.
   d. control the sludge blanket in the secondary clarifier.

4. A method commonly used to thicken activated sludge prior to treatment is:
   a. aeration.
   b. vacuum filtration.
   c. dissolved air flotation.
   d. sand filtering beds.

5. Which method below is not used to stabilize municipal wastewater treatment plant sludge?
   a. Lime stabilization
   b. Contact stabilization
   c. Anaerobic digestion
   d. Aerobic digestion

Skill Set 4 Safety

1. Most gas detectors available today conform to the industry standard and activate an alarm when what level is reached or exceeded?
   a. 0.1% LEL
   b. 10% LEL
   c. 100% LEL
   d. 100% UEL

2. Toxic gases that may be encountered by the industrial waste inspector include:
   a. carbon dioxide.
   b. hydrogen cyanide.
   c. nitrogen.
   d. sodium hydroxide.

3. What is the first safety-planning step prior to making a pretreatment inspection?
   a. Make an initial inspection of the facility to identify hazards
   b. Review all the MSDS on file at the facility
   c. Interview the pretreatment operator regarding workplace hazards
   d. Review the facility's industrial waste permit application and correspondence file

4. What is a common cause of oxygen deficiency in a sewer manhole?
   a. Exhaust from motor vehicles overhead
   b. Spills or discharges of oxidizing chemicals
   c. Bacterial action that displaces oxygen with other gasses
   d. Elevated temperatures and humidity

5. What is always required when working in a confined space?
   a. Use of self-contained breathing apparatus
   b. Continuous air monitoring
   c. Continuous ventilation
   d. Use of tripod hoist and harness

6. What type of personal protective equipment (PPE) would be considered Level C?
   a. Self-contained breathing apparatus
   b. Air purifying respirator
   c. Airline respirator
   d. Emergency escape air canister

7. What minimum equipment must be included in traffic control for working in the left lane of a 4-lane highway with a speed limit of 35 mph?
   a. “Road Work Ahead” sign, “Lane Closed” sign, vehicle with flashing light
   b. “Road Work Ahead” sign, “Lane Closed” sign, “Keep Left” sign, traffic cones to direct traffic around work area
   c. “Road Work Ahead” sign, “Left Lane Closed” sign, traffic cones to direct traffic around work area
   d. “Road Work Ahead” sign, “Keep Right” sign, barricades around work area

Skill Set 5 Applied Scientific Principles

1. A radiator shop has a 500 gallon muriatic acid cleaning tank with a pH of 2.5. The company wants to drain the tank to the sewage system. The company also has a 200 gallon caustic tank, NaOH, pH = 11.9, that needs to be drained. If the caustic tank is set for one gallon per minute (GPM), what must be the flow from the acid tank to maintain a pH of 7.0?
   a. 1.0 GPM
   b. 3.2 GPM
   c. 3.8 GPM
   d. 2.5 GPM

2. Industrial wastewater with a pH of 10.8 flows from an equalization tank to a neutralization-mixing tank at a rate of 9 GPM. Lab tests indicate that a 100 mL sample of the waste requires 11.3 mL of 0.5 N sulfuric acid to lower the pH to 7.0. Determine the setting in gallons per day on a chemical feed pump which is pumping 2 N sulfuric acid to the neutralization-mixing tank.
   a. 366 GPD
   b. 565 GPD
   c. 113 GPD
   d. 100 GPD

3. Zinc is being removed in a plating wastestream by hydroxide precipitation. Laboratory tests indicate that 1.8 milliliters of a four percent or one normal sodium hydroxide solution will increase the pH of one liter of wastewater to 10 and precipitate the zinc. What is the setting on the sodium hydroxide feed pump in gallons per day to treat a zinc wastewater flow of 10 GPM?
   a. 180 GPD
   b. 26 GPD
   c. 1.08 GPD
   d. 18 GPD

4. How much sulfur dioxide is required to treat 1,100 gallons of chromic acid containing 1,400 mg/L hexavalent chromium? Assume that one pound of hexavalent chromium is reduced to the trivalent state by the addition of three pounds of sulfur dioxide.
   a. 1.5 pounds
   b. 12.8 pounds
   c. 38.4 pounds
   d. 25.6 pounds

5. A cyanide-bearing waste is to be treated by a batch process using the alkaline chlorination method. The cyanide holding tank contains 6,000 gallons with a cyanide concentration of 15 mg/L. Seven pounds of caustic soda and eight pounds of chlorine are required to oxidize one pound of cyanide to nitrogen gas. How many pounds of chlorine are needed?

   a. 0.75 pounds

   b. 5.25 pounds

   c. 8.0 pounds

   d. 6.0 pounds

6. An industrial discharger has a wastewater flow of 10,000 gallons per day containing 4.5 mg/L of copper. What is the mass emission rate of copper in pounds per day?

   a. 0.38 pounds/day

   b. 0.45 pounds/day

   c. 4.5 pounds/day

   d. 0.17 pounds/day

7. A food processing plant discharges industrial wastewater at a rate of 45,000 GPD with a BOD of 3,500 mg/L and suspended solids (SS) of 1,300 mg/L. The company operates 260 days per year. Calculate the company's annual sewer service fee based on the following charges by the POTW: BOD is $100/1,000 pounds; SS is $200/1,000 pounds; flow is $500/Million Gallons (MG).

   a. $59,522

   b. $65,372

   c. $31,220

   d. $118,022

8. A metal finishing facility generates nickel-plating sludge from the clarifier of its pretreatment system. The clarifier sludge is 6,000 mg/L and 2 percent of the treatment plant inflow of 50,000 gallons per day. The sludge is dewatered in a filter press, 5 days per week, and shipped off site for disposal as hazardous waste once per week. If the filter press cake is 25 percent solids, how many pounds of dewatered sludge should be manifested as hazardous waste each week, assuming a cake density of 8.34 lbs/gallon?

   a. 1,400 lbs/week

   b. 120 lbs/week

   c. 1,000 lbs/week

   d. 1,200 lbs/week

Skill Set 6 Industrial Processes and Pretreatment

1. Which one of the following items is a major characteristic of wastes from the production of formaldehyde?

   a. BOD

   b. pH

   c. Suspended solids

   d. Temperature

2. Which one of the following items is a major characteristic of the wastes produced by a cannery?

   a. Color

   b. High dissolved organic matter

   c. Hardness

   d. Odors

3. While inspecting a chrome reduction tank in a pretreatment facility, you notice that the ORP reading is out of its proper range. The first thing you should check to determine the cause of the problem is:
   a. the range of pH values.
   b. the calibration of the ORP probe.
   c. the operation of the reducing reagent chemical feed pump.
   d. the supply of reducing reagent in the chemical feed tank.

4. Metal plating industries use ion exchange for:
   a. byproduct recovery.
   b. wastewater equalization.
   c. wastewater segregation.
   d. volume reduction.

5. For grease and solids removal, large meat processing plants typically use:
   a. grease traps.
   b. primary clarifier.
   c. dissolved air flotation.
   d. activated sludge.

6. A metal finisher is having difficulty meeting its chromium and zinc discharge limits using hydroxide precipitation. Soluble metals represent a high fraction in the effluent. The industry could improve the wastewater treatment process by:
   a. lowering the pH.
   b. increasing the pH.
   c. precipitating each metal separately.
   d. filtering the effluent.

7. An advantage and a disadvantage of sulfide precipitation for metals removal is:
   a. less chemical cost than lime, but higher sludge volume.
   b. lower effluent metal concentrations, but higher sludge volume than lime.
   c. lower effluent metal concentration, but higher corrosion potential from excess sulfide.
   d. less sludge volume than lime, but higher effluent metal concentrations.

8. A pH neutralization system uses a proportional pH controller to neutralize low pH wastewater with caustic. As the pH of the wastewater in the neutralization tank rises closer to the set point, the pH controller signals the caustic feed pump to:
   a. stop pumping.
   b. reduce the pump speed.
   c. increase the pump speed.
   d. increase the pump stroke.

9. A preliminary practice used by industry to reduce the strength of industrial wastes is:
   a. equipment maintenance
   b. flow metering
   c. good record keeping
   d. process-chemical substitution

10. A recoverable chemical from textile mill waste is:
   a. caustic soda
   b. soda ash
   c. sulfur dioxide
   d. sulfuric acid

Skill Set	7	Storm Water Quality

1. Non-storm water discharges to storm drains that are generally not permitted under municipal NPDES storm water discharge permits include:
   a. irrigation runoff.
   b. drainage from footing drains around buildings.
   c. air conditioner condensate.
   d. automobile detailing.

2. Industries discharging storm water under a General Storm Water Permit are required to sample:
   a. wastewater from all industrial processes.
   b. storm water from outside industrial activities.
   c. parking lot runoff.
   d. office roof drains.

Test Answer Key

Skill Set	1	Regulations and Permitting

No.	Answer	Skill Set
1	c	1.2
2	b	1.1
3	d	1.0
4	c	1.2
5	b	1.1
6	c	1.3

Skill Set	2	Environmental Monitoring and Sampling Techniques

No.	Answer	Skill Set
1	c	2.1
2	a	2.1
3	c	2.3
4	b	2.4
5	d	2.2

Skill Set	3	Wastewater Collection and Treatment

No.	Answer	Skill Set
1	c	3.2
2	d	3.2
3	b	3.2
4	c	3.3
5	b	3.3

Skill Set 4 Safety

No.	Answer	Skill Set
1	b	4.5
2	b	4.4
3	d	4.0
4	c	4.4
5	b	4.2
6	b	4.5
7	c	4.1

Skill Set 5 Applied Scientific Principles

No.	Answer	Skill Set
1	d	5.1
2	a	5.1
3	b	5.1
4	c	5.2
5	d	5.2
6	a	5.2
7	b	5.2
8	c	5.2

Skill Set 6 Industrial Processes and Pretreatment

No.	Answer	Skill Set
1	a	6.1
2	b	6.1
3	a	6.2
4	a	6.2
5	c	6.2
6	c	6.2
7	c	6.2
8	b	6.2
9	d	6.3
10	a	6.3

Skill Set 7 Storm Water Quality

No.	Answer	Skill Set
1	d	7.0
2	b	7.0

Selected Problem Solutions

Skill Set 5 Applied Scientific Principles

1. A radiator shop has a 500 gallon muriatic acid cleaning tank with a pH of 2.5. The company wants to drain the tank to the sewage system. The company also has a 200 gallon caustic tank, NaOH, pH = 11.9, that needs to be drained. If the caustic tank is set for one gallon per minute (GPM), what must be the flow from the acid tank to maintain a pH of 7.0?

   This is a basic chemistry problem involving neutralization of an acid by combining it with a caustic (or base). Neutral is defined as pH= 7, where pH = -log $[H^+]$ in moles per liter. Since the caustic is NaOH, pOH can be used to balance the pH of the muriatic acid. Adding OH^- to H^+ creates H_2O. pH + pOH = 14.

   The following approach to this problem calculates the total moles of hydrogen ions (H^+) and compares that to the moles of hydroxyl ions (OH^-).

   First, the acid tank contains 500 gallons at pH = 2.5. The pH equation is pH = -log $[H^+]$ where $[H^+]$ is the concentration of hydrogen ions in moles per liter.

   $2.5 = -\log [H^+]$

   Multiply both sides by -1 to get

   $-2.5 = \log [H^+]$

   Raise both sides to exponents (eliminates "log") to get

   $10^{-2.5} = [H^+]$

   Use your calculator to get

   3.162×10^{-3} moles/liter = $[H^+]$

Convert moles/liter to gallons and multiply by the gallons.

$$3.162 \times 10^{-3} \frac{\text{moles}}{\text{liter}} \times \frac{3.785 \text{ liters}}{\text{gallon}} \times \frac{500 \text{ gallons}}{1}$$

= 5.984 moles of hydrogen ions

Second, the caustic tank contains 200 gallons at pH = 11.9. Remember that 14 - pH = pOH.

pOH = 14 - 11.9 = 2.1

So, pOH = -log $[OH^-]$

2.1 = -log $[OH^-]$

where $[OH^-]$ is the concentration of hydroxyl ions in moles per liter.

Multiply both sides by -1 to get

-2.5 = log $[OH^-]$

Raise both sides to exponents (eliminates "log") to get

$10^{-2.1} = [OH^-]$

Use your calculator to get

7.943×10^{-3} moles/liter = $[OH^-]$

Convert moles/liter to gallons and multiply by the gallons.

$$7.943 \times 10^{-3} \frac{\text{moles}}{\text{liter}} \times \frac{3.785 \text{ liters}}{\text{gallon}} \times \frac{200 \text{ gallons}}{1}$$

= 6.01 moles hydroxyl ions

5.984 moles of H^+ neutralizes 6.01 moles OH^- (i.e., pH approximately equals 7) so the tanks must be drained simultaneously.

$$\frac{500 \text{ gallons acid}}{200 \text{ gallons caustic}} = 2.5$$

so the acid tank must be drained 2.5 times faster than the caustic tank.

The caustic tank drains at 1 GPM, so

1 GPM x 2.5 = 2.5 GPM flow from the acid tank

To check:

$$H^+ = \frac{2.5 \text{ gal}}{\text{min}} \times \frac{3.785 \text{ liters}}{\text{gallon}} \times 3.162 \times 10^{-3} \frac{\text{moles}}{\text{liter}}$$

= 0.0299 moles/minute H^+

$$OH^- = \frac{1 \text{ gal}}{\text{min}} \times \frac{3.785 \text{ liters}}{\text{gallon}} \times 7.943 \times 10^{-3} \frac{\text{moles}}{\text{liter}}$$

= 0.0301 moles/minute OH^-

2. Industrial wastewater with a pH of 10.8 flows from an equalization tank to a neutralization-mixing tank at a rate of 9 GPM. Lab tests indicate that a 100 mL sample of the waste requires 11.3 mL of 0.5 N sulfuric acid to lower the pH to 7.0. Determine the setting in gallons per day on a chemical feed pump which is pumping 2 N sulfuric acid to the neutralization-mixing tank.

This problem requires use of the formula:

$N_1V_1 = N_2V_2$

First set up the equation as above and solve for the normality of the wastewater using the experimental data.

N_{ww} x 100 mL = 0.5 N x 11.3 mL

$$N_{ww} = \frac{0.5 \text{ N} \times 11.3 \text{ mL}}{100 \text{ mL}} = 0.0565 \text{ N}$$

Similarly, set up the problem using the full-scale values.

$$0.0565 \text{ N} \times \frac{9 \text{ gal}}{\text{min}} \times \frac{1440 \text{ min}}{\text{day}} = 2 \text{ N} \times V_2$$

$$V_2 = \frac{0.0565 \text{ N}}{2 \text{ N}} \times \frac{9 \text{ gal}}{\text{min}} \times \frac{1440 \text{ min}}{\text{day}}$$

V_2 = 366 GPD

3. Zinc is being removed in a plating wastestream by hydroxide precipitation. Laboratory tests indicate that 1.8 milliliters of a four percent or one normal sodium hydroxide solution will increase the pH of one liter of wastewater to 10 and precipitate the zinc. Determine the setting on the sodium hydroxide feed pump in gallons per day to treat a zinc wastewater flow of 10 GPM.

This problem and its solution are similar to the one above. In the same two steps, solve for the wastewater normality and then for the volume of treatment chemical required.

N_{ww} x 1 L = 1 N x 1.8 mL

$$N_{ww} = \frac{1\text{N} \times 1.8 \text{ mL}}{1\text{L}} \times \frac{1 \text{ L}}{1{,}000 \text{ mL}} = 0.0018 \text{ N}$$

$N_{ww} V_{ww} = N_{base} V_{base}$

$$0.0018 \text{ N} \times \frac{10 \text{ gal}}{\text{min}} \times \frac{1440 \text{ min}}{\text{day}} = 1 \text{ N} \times V_{base}$$

$$V_{base} = \frac{0.0018 \text{ N}}{1 \text{ N}} \times \frac{10 \text{ gal}}{\text{min}} \times \frac{1440 \text{ min}}{\text{day}}$$

V_{base} = 26 GPD

4. How much sulfur dioxide is required to treat 1,100 gallons of chromic acid containing 1,400 mg/L hexavalent chromium? Assume that one pound of hexavalent chromium is reduced to the trivalent state by the addition of three pounds of sulfur dioxide.

   Known:

   Waste in gallons = 1,100 gal

   Concentration in mg/L = 1,400 mg Cr^{6+} /L

   Treatment in lbs/lb = 3 lbs SO_2/lb Cr $^{6+}$

   Calculate the pounds of Cr^{6+} to be treated:

   Treated lbs Cr^{6+}

   = MG waste x mg/L Cr^{6+} x 8.34 lbs/gal

   = 0.0011 MG x 1,400 mg/L x 8.34 lbs/gal

   = 12.8 lbs Cr^{6+}

   Calculate the dosage of sulfur dioxide:

   Pounds SO_2 Dosage

   = Treated lbs Cr^{6+} x lbs SO_2/lb Cr^{6+}

   = 12.8 lbs Cr^{6+} x 3 lbs SO_2/lb Cr^{6+}

   = 38.4 lbs SO_2

5. A cyanide-bearing waste is to be treated by a batch process using the alkaline chlorination method. The cyanide holding tank contains 6,000 gallons with a cyanide concentration of 15 mg/L. Seven pounds of caustic soda and eight pounds of chlorine are required to oxidize one pound of cyanide to nitrogen gas. How many pounds of chlorine are needed?

   First calculate the pounds of cyanide requiring treatment.

   lbs = flow x concentration x 8.34 lbs/gallon

   $$= 6{,}000 \text{ gal} \times \frac{\text{MG}}{1{,}000{,}000 \text{ gal}} \times \frac{15 \text{ mg CN}}{1 \text{ L}} \times 8.34$$

   = 0.7506 lbs CN

   Since eight pounds of chlorine are required for every one pound of cyanide:

   $$\frac{8 \text{ lbs Cl}}{1 \text{ lb CN}} \times 0.7506 \text{ lbs CN} = 6.0 \text{ lbs Cl}$$

6. An industrial discharger has a wastewater flow of 10,000 gallons per day containing 4.5 mg/L of copper. What is the mass emission rate of copper in pounds per day?

   Using the same formula as above,

   lbs = flow x concentration x 8.34 lbs/gallon

   $$= 10{,}000 \text{ gal} \times \frac{\text{MG}}{1{,}000{,}000 \text{ gal}} \times \frac{4.5 \text{ mg Cu}}{1 \text{ L}} \times 8.34$$

   = 0.3753 lbs Cu

   Selecting the best answer by rounding:

   mass emission rate of copper = 0.38 lbs/day

7. A food processing plant discharges industrial wastewater at a rate of 45,000 GPD with a BOD of 3,500 mg/L and suspended solids (SS) of 1,300 mg/L. The company operates 260 days per year. Calculate the company's annual sewer service fee based on the following charges by the POTW: BOD is $100/1,000 pounds; SS is $200/1,000 pounds; flow is $500/Million Gallons (MG).

   The suggested approach uses three steps that build upon each other. First, calculate the annual flow in MG:

   $$\frac{45{,}000 \text{ gal}}{\text{day}} \times \frac{260 \text{ days}}{\text{year}} \times \frac{\text{MG}}{1{,}000{,}000 \text{ gal}}$$

   = 11.7 MG/year

   Annual discharges of BOD and SS are calculated next.

   For BOD:

   11.7 MG/yr x 3,500 mg/L x 8.34 lbs/gal

   = 341,523 lbs/yr

   For SS:

   11.7 MG/yr x 1,300 mg/L x 8.34 lbs/gal

   = 126,851 lbs/year

   Calculate the annual sewer service fees using the appropriate charges.

   Flow:

   11.7 MG x $500/MG = $5,850

   BOD:

   341,523 lbs x $100/1,000lbs = $34,152

   SS:

   126,851 lbs x $200/1,000 lbs =$25,370

   $5,850 + $34,152 + $25,370 = $65,372 total

8. A metal finishing facility generates nickel-plating sludge from the clarifier of its pretreatment system. The clarifier sludge is 6,000 mg/L and 2 percent of the treatment plant inflow of 50,000 gallons per day. The sludge is dewatered in a filter press, 5 days per week, and shipped off site for disposal as hazardous waste once per week. If the filter press cake is 25 percent solids, how many pounds of dewatered sludge should be manifested as hazardous waste each week, assuming a cake density of 8.34 lbs/gallon?

   Calculate the mass of sludge generated per week.

   Flow:

   $$\frac{50{,}000\text{ gal}}{\text{day}} \times \frac{2}{100} \times \frac{5\text{ days}}{\text{week}} \times \frac{\text{MG}}{1{,}000{,}000\text{ gal}}$$

   = 0.005 MG/week

   Mass:

   0.005 MG x 6,000 mg/L x 8.34 lbs/gal

   = 250 lbs/week

   Since the cake is only 25 percent solids,

   $$\frac{250\text{ lbs solids}}{\text{wk}} \times \frac{100\text{ lbs sludge}}{25\text{ lbs solids}}$$

   = 1,000 lbs sludge/week

Secondary References

The information contained in the Primary References listed above provides a solid base of knowledge for the Inspector. The additional sources of information listed below may also be helpful for candidates seeking to broaden or refresh their knowledge in specific areas.

Industrial User Permitting Guidance Manual
NTIS Order No: PB92123017
Pub Date: September 1989
Office of Water (EN-336)
U.S. Environmental Protection Agency
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Call to Order: 800-553-6847
www.ntis.gov

The Nalco Water Handbook
Nalco Energy Chemicals Company
ISBN 0070458723
Pub Date: January 1, 1998
McGraw-Hill Professional Publishing Group
800/262-4729
www.mcgraw-hill.com

Chemistry for Environmental Engineering and Science
Clair Sawyer, Parry McCarty, and Gene Parkin
ISBN 0072480661
Pub Date: August 27, 2002
McGraw-Hill Professional Publishing Group
800/262-4729
www.mcgraw-hill.com

Industrial Wastewater Source Control: An Inspection Guide
Nancy Riikonen
ISBN 0877628556
Pub Date: December 11, 1992
www.amazon.com

Wastewater Sampling for Process and Quality Control – MOP OM-1
Order No: MF2010WW
Pub Date: 1996
Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
800/666-0206
www.wef.org

A Guide to Methods and Standards for the Measurement of Water Flow
G. Kulin and P. Compton
NTIS Order No: COM7510683
U.S. Department of Commerce
National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
888/584-8332
www.ntis.gov

*Safety and Health in Wastewater Systems – MOP 1*Order No: MO2001WW
Pub Date: 1994
Water Environment Federation
601 Wythe Street
Alexandria, VA 22314
800/666-0206
www.wef.org

Confined Space Entry, 1998 Edition
Order No: P07115WW
Water Environment Federation
601 Wythe Street
Alexandria, VA 22314-1994
800/666-0206
www.wef.org

Caltrans Signs & Delineation Branch Traffic Manual
Ch. 5 – Traffic Controls for Construction and Maintenance Work Zones (Rev. 2)
Download at: www.cwea.org/cert_howcert_preparing_resource.shtml

Basic Math Concepts for Water and Wastewater Plant Operators, 2nd Edition
Joanne Kirkpatrick Price
ISBN 0877628084
CRC Press LLC
800-272-7737
www.crcpress.com

Appendix A

You and Wastewater Math

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Example math problems found in Appendix A are representative of general wastewater math and are designed to illustrate a math problem solving strategy, not specific math skills. Examples given in this appendix may not be like the problems given on the test for your discipline. However, the problems are typical of types of problems you may encounter, including, but not limited to, basic algebra (solving one equation for one unknown), story problems, and plane and solid geometry (area and volume problems). For specific kinds of math skills and problems you may encounter on the certification test, please review Sections 3, 4, and 5 of this study guide.

Introduction

Now is the time for you to begin preparation for the math portion of your technical certification exam. This Appendix provides suggestions to take charge of:

- Your math skills
- Your attitudes toward math
- Your test-taking skills

By doing this, you can improve your performance in successfully completing the math questions on the certification exam.

Two Facts to Consider

First, since early childhood, you have used math mostly without giving it a second thought. Knowing your age, counting, comparing sizes and shapes, adding your money, and subtracting to get change are math skills.

You drive the streets judging distances, speeds, and times. You estimate if you can afford a vacation or a car and when you can retire. You compare volumes and areas as you build and do jobs around the work site. You even measure volume in putting toothpaste on your toothbrush. You use statistics as you watch sports and consider things like RBIs in baseball or field goal percentages in basketball. All of these are mathematical skills many people take for granted.

Second, if you think math is hard, please know that math becomes hard for *everyone* at some point. You are not alone. There are math problems that have been unsolved for hundreds of years even though they have been attempted by competent, well-informed mathematicians who may work at them for decades. Those are not the problems you need to work unless you are curious. When you work at your appropriate level, you find a combination of easy ideas and hard ideas.

You may get discouraged comparing your speed and understanding in math with others. Those people who appear to do math easily have, most likely, done those specific problems, or ones like them, many, many times.

You will want to study and progress at your "growing edge"—the skill level where you have a bit of discomfort with new material, but where you are not totally overwhelmed. You can expect challenges that trouble you, but that can be overcome. Instead of saying "I cannot do math," decide now to begin learning enough math to make work and test-taking easier.

Move Beyond the Math You Know

To move beyond your routine skill level in math, consider the following points:

You Have Skills.
You already have many math skills and can build on that base. It is best and easiest to build on what you already know.

Basics are Important.
Going back over the basics of what you know will build confidence and help you progress and add new math skills to your ability to solve math problems.

Math Progresses Logically.
There are many different areas of math and each builds on itself as well as on the others. If you cannot do a particular problem, it may be because you have missed something basic to that one area along the way. Working your way up slowly and cumulatively in math is the fastest way to gain skills.

Words Count.
Each and every word and symbol in math means something. You need to find out those meanings and then practice them. If you do not know what "mgd" or "psi" means, or which units measure "flow", it is harder to do problems involving them. It can seem like a foreign language.

Brains are Unique.
Each individual brain is wired differently, causing each person to think and learn differently. The more you know about the way you as a specific individual learn, the more you will permit yourself to do what it takes to learn math. Some people need to do many written repetitions. Some need to walk or move around as they do math. Some need to talk out loud. Others need to draw pictures. Some need to work problems with other people. Some need to use words and some need to use symbols. In order to focus on how to move forward, think about what works for you or where learning has been difficult for you.

If you are an independent learner, you might find a basic math book at your library to work through on your own. You may be able to study with your own children to learn some math together or with your friends and colleagues. You may have an old math book you used a long time ago that could be helpful, and you may come to remember what you learned from it.

Assessment Helps.
Assess your skill level honestly. Math placement tests are available at your local college and through private educational agencies to help you determine where your skills are and where you can best get help to make comfortable progress.

You are Not Alone.
No one promises that math will always be easy or interesting for you. For most people, working on math is a challenge. Persevering and pushing personal limits allows you to experience the satisfaction of success.

Get help when you get discouraged or experience confusion. Remember this is just a momentary problem in a sequence of ideas that you are confronting. Do not buy into the myth that you have to do math alone. Do not believe it is demeaning for you to admit you do not understand. You can have fun if you lighten up as you progress. Working with others is an outstanding way to improve math skills.

Questions are Essential.
Make a list of people with whom you feel comfortable discussing your math questions. They may be your colleagues, teachers, fellow students, friends, or family members—even your children. Do not ask just anybody; pick people who are helpful and positive or non-judgmental about your questions.

Mistakes Happen.
Expect mistakes up front. As you learn anything new, you will make errors. Do not blame your mistakes on math itself! In any new endeavor you need to allow yourself to crawl before you can walk. Successful people in all fields know this. Trial and error is the basis of all learning.

You can learn more from your mistakes than from repeated successes. Making errors gives you feedback by showing you what you do not understand. Learn to value and accept those errors and use them to find out what areas of your learning need more work. Correct them and then move on with new knowledge.

Learning Math is Not a Competitive Game.
Physicist Albert Einstein, politician Winston Churchill, and inventor Thomas Edison were all considered slow in school. Musical composer Ludwig Van Beethoven and scientist Louis Pasteur probably had learning disabilities. What all five certainly had was determination and patience to persevere. Only compete with yourself, pushing yourself forward, in learning math.

There is Hope for Those with Learning Disabilities.
If you really have a hard time learning, you might ask your local college or a private learning specialist to assess you for a learning disability. Many colleges and universities do free testing and training for their students. You can also purchase this kind of assistance from private consultants. Much is now known about learning disabilities and how to help people who have them. Learning

disabilities often become just learning differences as students learn to honor and use their own thinking and learning styles.

Math Success and Test-Taking Success are Not the Same.
Many math students understand and can work math problems, but have difficulty in test-taking situations. It is possible to know math and still fail exams. These people may find Section 4, Test Preparation very helpful. Conscious practice of both math skills and test-taking skills can make a big difference in your score.

Resources are Available.
Resources exist for all types of math. You will need to decide whether you will work on your math skills independently or with the help of some structure such as a math course or a tutor. Different strategies may work better at different stages in your progress.

Your local community college has inexpensive math courses. Some colleges even have math courses specifically for water and wastewater professionals. Professional organizations sponsor training conferences and seminars which include math courses specific to the field. Many agencies can provide in-house training and many agencies will provide individual help with all aspects of test taking.

Community Colleges
Community colleges offer several types of services including:

- Math Placement Testing
- Math Courses
- Water Utility Science Courses
- Math Anxiety Reduction Courses
- Testing and Training for those with Learning Disabilities

Professional Organizations
Organizations such as the California Water Environment Association (CWEA), American Water Works Association, and American Public Works Association also provide opportunities to practice your math skills and network with others:

- Technical Certification Training Classes and Annual Conferences
- CWEA Study Guides

At Work
Ask for help and suggestions from others who have taken math courses or are skilled in the work area similar to the one you are trying to prepare or improve. Ask your supervisor for advice on how to prepare and how much time on the job you can have to prepare. Ask your supervisor to provide training classes for the areas that you are wanting to improve. Ask those managing other departments, agencies, or local professional organizations for help in getting the training you need.

Materials
Any basic math book or instructional manual that you can beg, borrow, or buy, including:

- Courses from Ken Kerri, Office of Water Programs, California State University, Sacramento, 6000 J Street, Sacramento, CA 95819
- Price, Joanne Kirkpatrick. *Basic Math Concepts for Water and Wastewater Plant Operators, 2nd Edition.* Lancaster, Pennsylvania: Technomic, 1991; currently CRC Press LLC.
- Smith, Richard Manning. *Mastering Mathematics: How to Be a Great Math Student,* 3rd Ed. Pacific Grove, CA: Brooks/Cole, 1998.
- Zaslavsky, Claudia. *Fear of Math.* New Brunswick, NJ: Rutger University Press, 1994.

Practice Problem Solving Strategies

Wastewater math deals with only a handful of basic types of problems that involve moving liquids and semi-solids from place to place, and manipulating, storing, and treating these substances along the way.

So basically, understanding area, volume, slope, rates, concentrations, costs, and time elements that occur in wastewater treatment 24 hours per day, 365 days per year, pretty much covers what you need to know.

Units and Arithmetic

All wastewater math problems can be solved by simple arithmetic—adding, subtracting, multiplying, and dividing. You can become proficient with wastewater math by paying careful attention to the units in the problems as you write down your strategies, and then using a calculator to do the needed arithmetic.

Units

Units such as cubic feet, gallons, gpm, and mgd are important in wastewater math problems. Paying attention to the units will tell you whether to multiply or divide. Also, the units will often help you know what numbers to multiply or divide.

Notice in each example that doing math operations on the units produces the correct units in the answer. Many people do the math on the units first to figure out the correct procedure before they ever do the math on the numbers.

Multiplying

Multiplying is important. There are several symbols for multiplication. They are •, x, and ()().

For example,

$2 \bullet 3 = 2 \times 3 = (2)(3) = 6$

Dividing

Dividing is important to wastewater math because units often used such as MGD, cfs, ppm, GPM, psi, mg/L, GPD/sq ft, and % are really division problems.

"Per" stands for "divided by."

$$\text{MGD} = \frac{\text{million gallons}}{\text{day}}$$

$$\text{cfs} = \frac{\text{cubic feet}}{\text{second}}$$

$$\text{ppm} = \frac{\text{parts}}{\text{million}}$$

$$\text{GPM} = \frac{\text{gallons}}{\text{minute}}$$

$$\text{psi} = \frac{\text{pounds}}{\text{square inch}}$$

$$\text{mg/L} = \frac{\text{milligrams}}{\text{Liter}}$$

$$\text{GPD/square foot} = \frac{\text{gallons/day}}{\text{square foot}}$$

$$10\% = \text{ten percent} = \frac{10}{100}$$

Example Problems

Example 1

Plant No. 1 measured a flow of 3.5 million gallons in half a day. If the peak flow (hydraulic) capacity of the plant is 8 MGD, is there need for concern?

Using the conversion factor

$$\text{MGD} = \frac{\text{million gallons}}{\text{day}}$$

divide 3.5 million gallons by half a day.

$$\text{MGD} = \frac{\text{3.5 million gallons}}{\text{.5 day}} = 7 \text{ MGD}$$

7 MGD is less than the peak flow capacity, 8 MGD. There is no need for concern yet.

Example 2

a. Find the number of gallons in 10 cubic feet.

Since we can pour 7.48 gallons into a 1 cubic foot container, that means that 7.48 gallons = 1 cubic foot. We can use either factor:

$$\frac{\text{7.48 gal}}{\text{1 cu ft}} \text{ or } \frac{\text{1 cu ft}}{\text{7.48 gal}}$$

to convert cubic feet units into gallons or vice versa

$$\frac{10 \cancel{\text{ cu ft}}}{1} \times \frac{\text{7.48 gal}}{1 \cancel{\text{ cu ft}}} = \frac{(10 \cancel{\text{ cu ft}})(\text{7.48 gal})}{1 \cancel{\text{ cu ft}}}$$

= 74.8 gal

Notice that using the first factor allows the unit "cu ft" to cancel out leaving the answer in gallons.

b. Find the number of cubic feet in 10 gallons. Notice that using the second factor allows the unit "gal" to cancel out leaving the answer in cubic feet.

$$\frac{10 \cancel{\text{ gal}}}{1} \times \frac{\text{1 cu ft}}{7.48 \cancel{\text{ gal}}} = \frac{(10 \cancel{\text{ gal}})(\text{1 cu ft})}{7.48 \cancel{\text{ gal}}}$$

= 1.34 cu ft

You will notice how important it was in these examples to consider the units in deciding whether to multiply or divide by 7.48.

Example 3

a. Find the detention time for a basin with 675,460 gal if the flow is 1,000,000 gal/day.

Flow is always a rate which is division. Units like gpd or cfs are both division.

The formula for the basin detention time is:

$$Dt = \frac{\text{volume}}{\text{flow}}$$

$$Dt = \frac{675{,}460 \text{ gal}}{1{,}000{,}000 \text{ gal/day}}$$

$$= \frac{675{,}460 \text{ gal}}{1} \times \frac{\text{day}}{1{,}000{,}000 \text{ gal}} = 0.675 \text{ days}$$

b. Find the detention time for a 426 cubic foot basin if the flow is 1,000 cfs.

$$Dt = \frac{426 \text{ cu ft}}{1{,}000 \text{ cfs}} = \frac{426 \text{ cu ft}}{1{,}000 \text{ cu ft/sec}}$$

$$= \frac{426 \text{ cu ft}}{1} \times \frac{\text{sec}}{1{,}000 \text{ cu ft}} = 0.426 \text{ sec}$$

Example 4

Find the number of gallons of an 11% polymer needed to produce 100 gallons of a 0.75% solution.

Use the formula $C_1V_1=C_2V_2$ where C=concentration or % and V=volume.

You can let the volume you are looking for (i.e. the number of gallons of 11% polymer) be represented by V_1. Then C_1=11% or 0.11, C_2=0.75% or 0.0075, and V_2=100 gallons.

Using the formula $C_1V_1=C_2V_2$, you have $(0.11)(V_1) = (0.0075)(100)$

Notice to find V_1, you do the opposite of multiplying (i.e. dividing) by 0.11 on both sides. You then have

$$\frac{(0.11)(V_1)}{0.11} = \frac{(0.0075)(100)}{0.11}$$

and using a calculator, V_1=6.82. So, the amount needed is 6.82 gallons.

Example 5

How many hours will it take to empty a 43,000 cubic foot tank if it empties at a rate of 2.7 cubic feet per second?

Notice that dividing 43,000 cubic feet by 2.7 cubic feet per second would make the cubic feet unit cancel out. This would give us the time in seconds. To convert seconds into hours, use the factors

$$\frac{1 \text{ min}}{60 \text{ sec}} \text{ and } \frac{1 \text{ hr}}{60 \text{ min}}$$

The work is given below. Notice how the units cancel out leaving the answer in hours.

$$\text{Time} = \frac{43{,}000 \text{ cu ft}}{2.7 \text{ cu ft/sec}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1 \text{ hr}}{60 \text{ min}}$$

= 4.42 hr

Example 6

Find the number of gallons of water in a rectangular basin 200 feet long, 50 feet wide, and 12 feet deep.

First, find the volume of the rectangular basin by multiplying length by width by height. Volume = (200 ft)(50 ft)(12 ft) = 120,000 cubic feet or cu ft or ft^3.

You now have a problem similar to Example 2. How many gallons are there in 120,000 cubic feet? Use the factor

$$\frac{7.48 \text{ gal}}{1 \text{ cu ft}}$$

to convert cubic feet into gallons.

$$\text{Volume} = \frac{120{,}000 \text{ cu ft}}{1} \times \frac{7.48}{1 \text{ cu ft}}$$

= 897,600 gal

Example 7

A cylindrical tank is full to 3 feet below the top at 10 a.m. and empty at 4 p.m. If the tank is 50 feet tall with a diameter of 70 feet, find the volume (in gallons) of the liquid at 10 a.m. and the rate of flow from the tank in gallons per minute.

For a math problem with many words, I recommend always first writing down what you are trying to find:

(1) First, find the number of gallons of water in the tank at 10 a.m.

(2) Second, find the rate of flow in gal/min.

Drawing a sketch helps some people understand the problem and helps to keep track of the data.

I also like to write down and interpret the details that are given to me like:

Full to 3 ft below the top at 10 a.m.

Empty at 4 p.m.

Takes 6 hours to empty

a. First, to find the volume in gallons at 10 a.m., use the formula for volume of a cylindrical tank which is V=(area of the base) times (height).

To find the area of the base of the tank which is a circle, multiply 0.785 times the diameter squared.

So, the area of the base = $0.785(70^2)$
= 3,846.5 sq ft.

The height at 10 a.m. is 47 feet because the tank is filled to 3 feet below the top.

Volume = (area of the base)(height)
= $(3846.5\ ft^2)(47\ ft) = 180{,}785.5\ ft^3$

However, you want the volume in gallons so use the factor

$$\frac{7.48\text{ gal}}{1\text{ cu ft}}$$

to convert.

$$\text{Volume in gallons} = 180{,}785.5\ \cancel{ft}^3 \times \frac{7.48\text{ gal}}{1\ \cancel{ft}^3}$$

= 1,352,275.54 gal

b. Second, to determine the rate of flow in gallons per minute, divide the number of gallons by the number of minutes it took the tank to empty. It took 6 hours to empty. To convert 6 hours to minutes, use 60 min = 1 hr or factors

$$\frac{60\text{ min}}{1\text{ hr}} \text{ or } \frac{1\text{ hr}}{60\text{ min}}$$

to convert. You want the hour unit to cancel out, so you will use the first factor. The time becomes:

$$\frac{6\ \cancel{\text{hrs}}}{1} \times \frac{60\text{ min}}{1\ \cancel{\text{hr}}} = 360\text{ min}$$

Rate of flow in gal per minute =

$$\frac{1{,}352,\ 275.54\text{ gal}}{360\text{ min}} = 3{,}756.32\text{ gal per min}$$

Take Charge of Your Success

The key to progress with math is to consciously take charge of your thoughts and actions. Then, instead of letting math control you, you control math and you take charge of your success.

Recommendations

Ask Questions.
Be active and assertive. Learning is not a spectator sport. You cannot learn well from the sidelines. Get involved. Work problems and keep asking questions until they become clear. In classes and seminars, ask questions on confusing procedures.

Take It Easy.
When you get stuck working problems, hang in for a while and then take a break. Go back later, begin at the beginning with a clean sheet of paper and a different point of view. Just because you do not understand at first does not mean understanding will not come. Math learning requires time to settle into your brain. Being able to live with uncertainty for a while is a good math skill to have.

Keep a List.
Write down your resources (books, tutors, people to answer questions, people who understand) so that you can consult them when you get discouraged. You are not alone. Find helpful people with whom you are comfortable. Form a network with others working toward the same goals as you.

Find Yourself.
Discover your own unique ways of learning. Experiment with new ones. If a method does not work, find others. Ask different people how they learn math or do a problem. They will often feel honored and pleased that you asked them and you might get a breakthrough idea.

Be Positive.
Listen to what you say to yourself inside your head. It is difficult to work well if you are saying, "I will never get this" or "I cannot do math." Change those negative messages to neutral ones like "I have not learned this *yet*" or "I cannot do this particular problem *yet*."

Reward Yourself.
Acknowledge your progress—every little bit! Pat yourself on the back for each and every problem you work. Notice what you know now that is new that you did not know two weeks ago. Maybe even write it down to document your growth.

Learn From Mistakes.
Remember that errors are part of the learning process. Pay attention to them and figure out where they happened and how to fix them.

Keep It Real.
Be realistic with your expectations of yourself—your math level, your life commitments, and your time constraints. Do not beat yourself up for being a human being.

Use Technology.
Learn to use a calculator and use it appropriately for calculations with large numbers and decimals. Each brand of calculator is different, so keep your manual for reference. Take spare batteries to exams.

Start Easy.
Practice the easier math problems to warm up each time you begin your math study. This builds confidence and strengthens those math pathways in your brain.

Use Paper.
Keep scratch paper available and expect to use it for your math work. You need empty space on paper to think and do calculations.

Promote Emotional Well Being.
Patience, self-care, and humor will make your math work so much easier. Your brain will work better too.

Be Healthy.
You are making new connections in your brain as you practice math, so sufficient sleep and healthy foods are important. Having fresh drinking water available and breathing fresh air also helps you think better.

Test-Taking Strategies

There are many actions you can take before, during, and after exams that will improve your test-taking performance and outlook. Remember that math skills and test-taking skills are different from each other. This section will help you become conscious of your thoughts and actions regarding test preparation. Use these suggestions to take charge and approach your test confidently.

If you find yourself thinking negative thoughts about your coming exam, skip to the last section and read "Negative Thinking about Exams" first.

Before the Exam

Work Problems.
Diligently prepare and practice. Repeat solving problems to gain speed and confidence. This takes work and time—sometimes many hours, even days. Going in to an exam with the knowledge that you have worked lots of problems boosts confidence. Prep time is invaluable.

Relax.
Practice relaxation daily for about at least ten minutes using breathing. Sitting or lying comfortably, breathe slowly in through your nose counting to five and then out through your mouth counting to ten. If you feel dizzy, breathe normally for a while. Deep breathing activates chemicals in your body that help you relax and feel better. Any type of regular meditation, yoga, or slow stretching while breathing deeply can help facilitate your relaxation response. Practicing daily will help you control your adrenaline level during your exam. Using relaxation consciously during an exam frees up the thinking part of your brain. (Do not practice these deep breathing exercises while you are driving.)

Stay Active.
Daily walks or biking or whatever aerobic exercise you use consistently prepares your body for your exam by relieving stress and keeping your state of mind positive. Your mind and your body are connected so tightly that they are nearly the same.

Rehearse.
Do a dress rehearsal for your exam. Write or have someone assist you in writing a practice test with problems and questions that you think might be on the real exam. Use questions from the diagnostic test in Section 5 of this study guide. Give yourself this practice test in an environment as close to your testing situation and schedule as possible. Time it and then correct it to learn from your errors.

Plan Ahead.
Plan ahead carefully so that you will get to the exam early—do not be in a rush. Know exactly how to get there and what you will wear so that you are comfortable. You might want to wear your "lucky" shirt or bring a photograph of people who care about you and believe in you. WHATEVER you can do to increase your sense of comfort and security, do it. Ahead of time, pack a Testing-Taking Kit with sharp pencils, pens, a ruler, erasers, tissues or handkerchief, a bottle of water, extra calculator batteries, and anything else you think you might need that is allowed at the test.

Care For Your Body.
Optimal food and rest are individual preferences. Plan these ahead of time. Some research has shown that a brisk walk before an exam has raised test results. Some research has shown that eating a few candies (not chocolate) right before an exam has raised test results. Protein appears to be essential for clear thinking. Be in charge of what happens to you before the exam. Do not let outside influences take charge of you for this little time before your test.

At the Exam

Do a Data Dump.
Bring a short list of formulas or facts you find difficult to remember. Look at them before the test. Visualize them going into a holding tank in your brain. Practice making them subject to recall. If you are not allowed to use notes on the exam, be sure to put the list away so that your honesty is not questioned. When you receive your test, quickly write these formulas or facts on your exam paper. Now you do not have to expend any energy trying to recall them later when you need them.

Ignore Others.
Ignore all of the other people at the exam—before, during, and maybe even after. Different people have different ways of dealing with their anxiety during tests. Some people get a little hyper and try to rub off their anxiety on everyone else. Do not take on someone else's anxiety. Your test is not a competition, so what other people do will not affect your score. Often the first person to leave an exam gets a very low score, while the last person to leave gets a very high score. Take your time. Pay no attention to other people's behavior.

Breathe.
When you feel stuck or tense, take a deep breath. Let it all go as you expel the air. (The more you have practiced relaxation and deep breathing before the exam, the more you will relax during the test.)

Take Time Out.
Take short breaks during the exam to close your eyes, breathe deeply, and stretch your neck and arms. Massaging your temples, scalp, and the back of your neck will increase blood flow with oxygen to your brain to help you think better. A few isometric exercises can release tension too.

Use Your Subconscious Mind.
If a problem makes no sense, read it and go on. Ideas will come to you as the problem sinks into your subconscious mind while you continue with the test.

Trust.
Let each question reach into your mind for the answer. Remind yourself that you know everything you need to know for now.

Strategize.
Do the easy problems and questions first. Make pencil marks by the questions to which you want to return.

Use Time Wisely.
Do not work on one problem for a long time. Often a question further into the exam will act as a "key" to unlock a previous problem. Tell yourself that you have all of the time you need. Let go of the rest of your life during the exam. You can deal with all that later.

After the Exam, Let the Results Go.
You have used a lot of energy and may be low and off balance. You may wish to pass up discussing the exam with others so you can take care of yourself. Going to the bathroom, drinking some water, and eating something can help you feel normal again. You may have set much of your life aside to prepare for this exam. Refresh yourself and get your life back. You can deal with the test results later when your priorities are in order again.

Negative Thinking About Exams

Here are negative thoughts math students often think before test-taking. Put a check mark by the examples familiar to you. Recognizing the distorted thinking in each example can help you change negative thoughts to neutral or positive ones. If you need more assistance with overwhelming negative thoughts, I recommend the book *Feeling Good* by David Burns (WholeCare, 1999).

"I Will Fail."
Unless you have a crystal ball and can see into the future OR unless you have made a definite plan NOT to prepare for the test OR unless you plan to "freeze up" during the exam, you have no way of knowing whether you will fail or not. Worrying about the future only takes energy from today.

"I Will Panic During the Test."
It is not uncommon to be excited. An exam is a process during which you will experience many thoughts, feelings, and body sensations. Actors get nervous, yet they still perform. If you do panic, let panic leave you. It will. No one dies from panicking during an exam.

Preparation by practicing problems, asking questions, and reviewing gives you confidence and skills that you need. Taking a dress rehearsal test and trying to panic can help you practice dealing with out-of-control feelings. Learning some relaxation techniques to use before and during the exam calms you and aids clear thinking. The more you prepare yourself ahead, the more you are in charge and feel relaxed.

"I Cannot Do Math."
Math is a very broad subject involving many different skills. If you can recognize shapes, tell time, and know where the front and back of a classroom are, you can already do math. There are many more math skills that you have and many that you do not have YET. There are also many that you will never choose to acquire. Instead of thinking so absolutely about math, find areas where you can grow and learn new skills instead of paralyzing yourself with this broad generalization.

"I Am Stupid."
Name calling is seldom productive. Occasionally you may feel stupid because you do not know something or you mess up. What really is happening is that you are being human and humans are not stupid. Educators recognize the need to change how everyone thinks about intelligence. They recognize that there are many different kinds of intelligence including:

- bodily/kinesthetic
- verbal/linguistic
- naturalist
- logical/mathematical
- visual/spatial
- interpersonal
- intrapersonal
- musical/rhythmic

This comes from the work of Howard Gardner. (Gardner, Howard. *Multiple Intelligences: The Theory in Practice.* New York: Basic Books, 1993.)

You are a wonderful combination of these talents—not just an IQ number. IQ Tests are limited because they only measure a few types of intelligence and ignore the rest. We are not all the same and cannot possibly know all there is to know in every situation. Between now and the exam, there are many questions you can get answered as well as many new skills you can practice and master if you use the skills and intelligence that you have.

"I Will Forget Everything."
Forgetting does not mean something is gone from your mind forever. The right cue will often help you remember what you need to know. Your exam will be filled with cues—words and symbols—that will trigger formulas and ideas you have practiced.

Expecting to forget "everything" is foretelling the future and making a broad generalization. Even most people with amnesia caused by illness or injury do not forget "everything." If you are extremely worried about your memory, *The Great Memory Book* by Karen Markowitz and Eric Jensen (The Brain Store, 1999) can be of assistance to you.

"Math Tests Are Tricky."
Math students who rely on memorizing the material rather than understanding it are usually the ones who think tests are tricky. You will use your memory to add to your understanding of how to do the math. Your math problems will contain many units such as mgd or ft^3 or psi. Learning how to skillfully convert back and forth between units of measure will take a lot of the trickiness away from your test problems. Practicing using your calculator will help too.

"There Is So Much I Do Not Know."
This will always be the case the rest of your life. It is the human condition. Taking a deep breath and finding the level where you can begin to learn will improve your feelings and your confidence.

Appendix B

Glossary of Technical Terms

40 CFR 121–124: The federal storm water regulations for the permitting of municipalities and industries. Regulations define storm water terms, permitting, inspecting, and sampling requirements.

40 CFR 136: The regulations for sampling preservation and analyses of water, wastewater, and solid waste.

40 CFR 403: The federal regulations defining the elements of a pretreatment program, prohibited discharges, and the approval process for establishing a pretreatment program.

Acid: A compound which liberates hydrogen ions and has a pH below 7.

Alkalinity: The measurement of a sample's capacity to neutralize acid.

Atomic Weight: The sum of the number of protons and the number of neutrons in the nucleus of an atom. Atomic weights of elements are found on periodic tables.

Base: A compound which liberates hydroxide ions and has a pH above 7.

Biochemical Oxygen Demand (BOD): The quantity of oxygen utilized in the biochemical oxidation of organic matter under standard laboratory procedures for five days at 20° Centigrade, usually expressed as a concentration (e.g., mg/L). BOD measurements are used to indicate the organic "strength" of wastewater.

Biological Treatment: A waste treatment process by which bacteria and other microorganisms break down complex organic or inorganic (e.g., ammonia) materials into simple, nontoxic, more stable compounds.

Categorical Industrial User (CIU): An industrial user (see IU definition below) that is subject to a categorical standard promulgated by the U.S. EPA.

Centrifugal Pumps: Pumps using centrifugal force to convey liquid. Discharge will vary according to inlet and discharge pressure.

Chain-of-Custody: A legal record (which may be a series of records) of each person who had possession of an environmental sample, from the person who collected the sample, to the person who analyzed the sample in the laboratory, to the person who witnessed the disposal of the sample.

Chemical Oxygen Demand (COD): The amount of oxygen (expressed in mg/L) consumed from the oxidation of a chemical during a specific test. As such, COD is a measure of the oxygen-consuming capacity of the organic matter present in wastewater. The results of the COD test are not necessarily related to the BOD, because the chemical oxidant responsible for utilizing the oxygen may react with substances which bacteria do not stabilize.

Cipolletti Weir: A trapezoidal sharp-crested weir for measurement of liquid discharge in open channels.

Clean Water Act (CWA): The federal Clean Water Act sets the framework for the imposition of industrial wastewater control programs on municipalities and the regulation of industrial users. Sections 307(b) and (c) of the CWA set forth the authority for the U.S. EPA to establish pretreatment standards for existing and new sources discharging industrial wastewater to publicly owned treatment works (POTWs).

Composite Sample: A collection of individual samples obtained at regular intervals, based either on flow or time. The individual samples are combined proportionally.

Concentration Based Discharge Limits: Allowable concentration of a pollutant in wastewater discharges, usually expressed as a concentration (i.e., mg/L) in the discharge.

Confined Space: A space which has limited openings for entry and exit, has unfavorable natural ventilation which could contain or produce dangerous air contaminants (or create an atmosphere of oxygen deprivation), and which is not intended for continuous employee occupation. A permit may be required under OSHA to enter a confined space.

Density: The relationship between weight and volume, e.g., grams per cubic centimeter or pounds per gallon.

Detention Times: The residence time of wastewater undergoing treatment in a treatment unit such as a clarifier or tank. Minimum detention times are required for settling, chemical treatment, and biological treatment.

Doppler Flow Meter: An ultrasonic flowmeter that measures the velocity of liquid in a pipe flowing full.

Electroplating: The process of applying a thin metal coating to the surface of a metal (substrate) by electrodeposition of dissolved metal in a plating solution.

Flow Equalization: Temporary storage of wastewater flow to provide more uniform flow or waste characteristics for treatment or discharge.

Grab Sample: A sample which is taken from a wastestream without regard to the flow in the wastestream, and over a period of time not to exceed 15 minutes.

Holding Time: The maximum time allowed between when a sample is taken and when it must be analyzed in the laboratory, in accordance with standard preservation, storage, and analytical procedures.

Hydrogen Sulfide (H_2S): Dissolved sulfide is produced by the biological reduction of sulfate and organic matter under anaerobic (oxygen-free) conditions. Dissolved sulfide can combine with hydrogen to form hydrogen sulfide gas. H_2S gas is potentially hazardous to sewer maintenance workers.

Industrial User (IU): Any non-domestic source which introduces pollutants into a POTW.

Industrial Wastewater: Any non-domestic wastewater (excluding storm water).

Magnetic Flowmeter: A flowmeter that creates a magnetic field across a pipe flowing full, in which the liquid acts as a conductor to measure the velocity and flow in the pipe.

Mass Based Limits: Discharge limits based on allowable dry weight of pollutant, usually expressed in pounds per day (lbs/day).

Mass Emission Rate: The rate of discharge of the dry weight of a pollutant in wastewater or air, expressed in lbs/day or kilograms per day (kg/day).

Material Safety Data Sheets (MSDS): Sheets providing information about manufactured chemicals, as required by the Hazard Communication Rule.

Molarity: Moles per liter; a measure of concentration.

Molecular Weight: The sum of the atomic weights of all atoms making up a molecule.

National Pollutant Discharge Elimination System (NPDES): The federal permitting program designed to control all discharges of pollutants from point sources into U.S. waterways, as required under the CWA.

National Prohibited Discharge Standards: Prohibitions, applicable to all nondomestic dischargers, regarding the introduction of pollutants into POTWs as set forth in 40 CFR 403.5.

Neutralization: Addition of an acid or alkali (base) to a liquid to cause the pH of the liquid to move toward a neutral pH of 7.0.

Normality: A measure of the concentration of a solution.

Oxidation-Reduction: Reactions involving the transfer of electrons, with oxidation being the loss of electrons and reduction being the gain of electrons. ORP, or oxidation-reduction potential, is the qualitative measure of the state of oxidation in metal waste treatment systems. ORP is used to control the chemical addition to optimize the oxidation of compounds such as cyanide or reduction of metals such as hexavalent chromium.

Parshall Flume: An open channel flow measuring device with a constricted throat that produces a head or water depth that is related to discharge.

Pass-Through: The passage of untreated pollutants through a POTW which could violate applicable water quality standards or NPDES effluent limitations.

pH: The hydrogen ion (H^+) concentration; the measure of the relative acidity or alkalinity of a solution on a scale from 0 (acidic) to 14 (basic).

Pollutants of Concern (POC): Compounds in wastewater that pose a potential threat to the POTW or its ability to comply with environmental standards.

Positive Displacement Pumps: Pumps that use pistons, diaphragn action, etc., to convey liquid. The discharge rate of these pumps does not vary with inlet or outlet pressure.

Pretreatment Standard: Any regulation promulgated by the EPA in accordance with Sections 307(b) and (c) of the Clean Water Act, applying to a specific category of industrial users and providing limitations on the introduction of pollutants into POTWs. This term includes the prohibited discharge standards under 40 CFR 403.5, and includes local limits set forth under 40 CFR 403.3 (j).

Precipitation: Part of a treatment process that takes dissolved pollutants out of solution to form a precipitate that can be removed by filtration or settling.

Printed Circuit Board: A circuit for electronic apparatus made by depositing conductive material, usually copper, on an insulating surface.

Process-Inhibition: The concentration of a pollutant that will interfere with a biological treatment process in the POTW.

Publicly Owned Treatment Works (POTW): A treatment works which is owned by a state, municipality, city, town, special sewer district, or other publicly owned and financed entity, as opposed to a privately owned (industrial) treatment facility. This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of liquid nature. It also includes sewers, pipes and other conveyances only if they convey wastewater to a POTW treatment plant. The term also means the municipality (public entity) which has jurisdiction over the indirect discharges to and the discharges from such a treatment works.

Settling: The treatment process by which settleable or floatable solids are removed from wastewater by gravity separation in a tank or other vessel.

Sludge Quality Standard: Allowable concentration or mass of a pollutant in POTW sludge, or biosolids, used for land application.

Specific Gravity: (1) The weight of a particle, substance, or chemical solution in relation to the weight of an equal volume of water. Water has a specific gravity of 1.000 at 4°C (39°F). (2) The weight of a particular gas in relation to an equal volume of air at the same temperature and pressure. Air has a specific gravity of 1.0. Chlorine, as a gas, has a specific gravity of 2.5.

Total Suspended Solids (TSS): Residue (expressed as mg/L) that is removed from a wastewater sample by a standard laboratory filtration procedure.

Turbine Meter: A positive displacement meter with an internal turbine turned by the water flow. Flow is proportional to the turbine rotation speed.

V-notch Weir: A triangular sharp-crested weir for measurement of liquid discharge in open channels.

Worker Right-to-Know Laws: Legislation that requires employers to inform employees of the possible health effects resulting from contact with hazardous substances. At locations where this legislation is in force, employers must provide employees with information regarding any hazardous substances that they might be exposed to under normal working conditions or reasonably foreseeable emergency conditions resulting from workplace conditions. OSHA's Hazard Communication Standard (HCS) (29 CFR Part 1910.1200) is the federal regulation. There are also state statutes that are called Right-to-Know Laws.

Appendix C

Common Acronyms and Abbreviations

AA	atomic absorption
AC power	alternating current
AC	acre
AF	acre-foot (feet)
AFY	acre-foot per year
AMSA	Association of Metropolitan Sewerage Agencies
ANSI	American National Standards Institute
APHA	American Public Health Association
AS	activated sludge
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWT	advanced wastewater treatment
AWWA	American Water Works Association
BECP	Business Emergency and Contingency Plan
BNR	biological nutrient removal
BOD5	biochemical oxygen demand after 5 days
BTU	British thermal unit
C	Celsius
Cal-OSHA	California Occupational Safety and Health Act
Cal-EPA	California Environmental Protection Administration
CBOD	carbonaceous biochemical oxygen demand
CCE	carbon chloroform extract
CCR	California Code of Regulations
cf	cubic feet (foot)
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_4	Methane
CIU	Categorical Industrial User
CM	common mode
CMOM	Capacity Management, Operations, and Maintenance
COD	chemical oxygen demand
CPU	central processing unit
CRWA	California Rural Water Association
CSP	confined-space permit
CT	current transformer
CWA	Clean Water Act
CWEA	California Water Environment Association
DAF	dissolved air flotation
DO	dissolved oxygen
DOHS	California Department of Health Services
DV/DT	($\Delta V/\Delta T$) The change in voltage per change in time.
DWF	dry weather flow
DWR	Department of Water Resources
EIS	Environmental Impact Statement
EMF	electromotive force or voltage
EPA	U.S. Environmental Protection Agency
F	Fahrenheit
F/M	food to microorganism ratio
ft	feet (foot)
ft^2	square foot
ft^3	cubic feet
FTU	formazin turbidity unit
GAC	granular activated carbon
gal	gallon

GFI	ground fault interrupter
GPD	gallons per day
GPM	gallons per minute
GTAW	gas tungsten arc welding
H_2S	hydrogen sulfide
HCP&ERP	Hazard Communications Program and Emergency Response Plan
hp	horsepower
HPLC	high-performance liquid chromatography
Hz	Hertz
IC	ion chromatograph
ICP	inductively coupled plasma
IEEE	Institute of Electrical and Electronics Engineers
IIPP	Injury and Illness Prevention Plan
IML	Interface Management Language
JTU	Jackson Turbidity Unit
K	Kilo, a prefix meaning 1,000
KVA	kilovolt amperes
kw	kilowatt
kwh	kilowatt hour
L	liter
lb	pound
M	Mega, a metric prefix meaning 1,000,000
m	meter
M	mole or molar
MA	millamps
MBAS	methylene blue active substance
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCRT	mean cell residence time
MDL	method detection limit
MG	million gallons
mg	milligram
mg/L	milligrams per liter
MGD	million gallons per day
min	minute
MIS	Manufacturing Information System
mL	milliliter
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
MMI	Man Machine Interface
MOP	Manual of Practice
MPN	most probable number
MS	mass spectrometer
MSDS	Material Safety Data Sheets
MTBF	mean time between failures
MTTR	mean time to repair
N	normal
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NEPA	National Environmental Policy Act
NM	Normal Mode
NOCA	National Organization for Competency Assurance
NOD	nitrogenous oxygen demand
NPDES	National Pollutant Discharge Elimination System
NPSH	net positive suction head
NTU	nephelometric turbidity unit(s)
O&M	operation and maintenance
OCT	Operator Certification Test (State of California)
OMR	operations, maintenance, and replacement
OOC	Office of Operator Certification (SWRCB)
OSHA	Occupational Safety and Health Administration/Act
OTE	oxygen transfer efficiency
P	Pico, a metric prefix meaning one millionth of a millionth, or one trillionth (10^{-12})
PC	personal computer

PCB	polychlorinated biphenyls
pH	potential of hydrogen
P&ID	piping and instrumentation diagram
PID	proportional gain, integral action time and derivative action time
PLC	Programmable Logic Controller
POTW	Publicly Owned Treatment Works
PPB	parts per billion
PPE	Personal Protective Equipment
PPM	parts per million
prct	percent
psi	pound per square inch
PSIA	pounds per square inch absolute
PSID	pounds per square inch differential
PSIG	pounds per square inch gage
PVC	polyvinyl chloride (pipe)
QA/QC	quality assurance/quality control
RAS	return activated sludge
RBC	rotating biological contactor
RCP	reinforced concrete pipe
RFI	Radio Frequency Interference
RMS	root mean square
RTD	resistance temperature device
RWQCB	Regional Water Quality Control Board (State of California)
SCADA	Supervisory Control and Data Acquisition
SCR	semiconductor (or silicon) controlled rectifier
SD	standard deviation
SDI	sludge volume index
sec	second
SI	System Internationale D’Unites (metric units)
SS	suspended solids
SSO	sanitary sewer overflow
SVI	sludge volume index
SVR	sludge volume ratio
SWRCB	(California) State Water Resources Control Board
TAC	Technical Advisory Committee
TC	total carbon
TCP	Technical Certification Program
TDS	total dissolved solids
TF	trickling filter
THD	total harmonic distortion
TIC	total inorganic carbon
TMDL	total maximum daily load
TOC	total organic carbon
TOD	total oxygen demand
TS	total solids
TSS	total suspended solids
TU	turbidity unit
μ	micro, a metric prefix meaning one millionth
UPS	uninterruptible power supply
USB	universal serial bus
USEPA	United States Environmental Protection Agency
V	volt
VAC	volts of alternating current
VCP	vitrified clay pipe
VFD	variable frequency drive
VOC	volatile organic chemicals
VOM	volt Ohm meter
VSR	volatile solids reduction
VSS	volatile suspended solids
W	watt
WAN	wide area network
WEF	Water Environment Federation
WRP	water reclamation plant
WWF	wet weather flow
WWTF	wastewater treatment facility
WWTP	wastewater treatment plant (same as POTW)
yr	year

CWEA is pleased that you have purchased this book.

We want to remind you that this book is one of many resources available to assist you, and we encourage you to identify and utilize the other resources in preparing for your next test.

Your comments, questions, and suggestions are welcome.

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